SCIENCE

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FRIDAY, JULY 6, 1900.

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MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FROM the point of view of scientific work the New York meeting of the Association was the most successful in its history, with the possible exception of the anniversary meeting held two years ago at Boston. It was not expected that New York City would be a favorable place to awaken local enthusiasm or altogether suitable for social gatherings, but even in these respects there were no grounds for complaint. The attendance—a registration of about 450—was not as large as had been hoped for. It included, however, an unusually large proportion of fellows, and there were perhaps three hundred members of the affiliated Societies present who did not register as members of the Association. The assembly of scientific men was therefore abo t as large as it ever has been, and considerably larger than since 1884, with the exception of the anniversary meeting.

The general conduct of the meeting met with the approval of nearly all the members, though a few regretted the lack of eleemosynary entertainments and excursions. The members were welcomed to Columbia University by President Low and to the American Museum of Natural History by President Jesup. The address of the presi-

dent, Professor Woodward, who presided with admirable dignity and tact, is printed below, while last week we were able to publish the address of Mr. Gilbert, the retiring president, which was a model of what such an address should be. Scientific excursions were made to the Botanical Gardens, to the Zoological Park, to the American Museum, to the Marine Laboratory at Coldspring Harbor and elsewhere, but the special feature of the meeting was the number and importance of the papers presented before the sections and affiliated societies.

The scientific pre-eminence of the meeting was due to these special scientific societies holding sessions in conjunction with the Association. The American Chemical Society always has a large attendance and crowded program. It was the first society to become definitely affiliated with the Association, and the result has been to make chemistry the leading science at the meetings. The Botanical Society of America, The Society for the Promotion of Agricultural Science and the American Forestry Association have given botany a place next to chemistry. But this year, for the first time since the beginning of the movement toward special societies, chemistry and botany were rivalled by the work of sections A and B. The American Mathematical Society and the Astronomical and Astrophysical Society of America met with the section for mathematics and astronomy and the American Physical Society with the section for physics, and these sections held meetings of unusual importance. The Geological Society of America strengthens Section E, but unfortunately for the Association the most active geologists are likely to be in the field at the time of the meeting. The work of the Zoological section was unusually good this year. The Association of Economic Entomologists and the American Microscopical Society met with the Association, but the American Morphological Society and the American Ornithologists Union have not hitherto co-operated. Anthropology was strengthened, though only to a limited extent, by the American Psychological Association and the American Folk-lore Society. There were no special societies meeting in conjunction with Section D, Mechanical Science and Engineering, or with Section I, Social and Economic Science, and these are the two weakest sections of the Association. The Society for the Promotion of Engineering Education, which met after the adjournment of the Association, should join with Section D, and every effort should be made to secure the co-operation of the great engineering societies. In like manner the national societies devoted to social and economic science should be persuaded to meet with Section I, and perhaps special societies should be formed relating to the scientific aspects of commerce and education. There is no question that the special societies are strengthening the Association, the only drawback being that many of the members do not join the parent body. As they take advantage of the reduced railway rates and other arrangements for the meetings there is every reason for them to defray their share of the cost. Indeed it is obviously the duty of all men of science to support the historic and general association, whose influence is proportionate to its membership.

Although the annual dues are very moderate — only $3, while they are $5 in the British and French Associations—many members of other scientific societies think that they do not receive an adequate return for membership. It is a fact that owing to the wide dispersion of men of science in America and the difficulties of long journeys in mid-summer fewer than one fourth of the members attend the meetings. There is consequently hesitation in joining the Association and a tendency to let member-

ship lapse. The Association, however, took action at the recent meeting that will give even to those who are unable to attend the meetings a definite and adequate return for membership. The Council unanimously decided to send SCIENCE free of charge to all members of the Association next year and to publish in it official notices and proceedings. This action will increase the membership of the Association and the interest of the members in its work, while at the same time extending the influence of this JOURNAL, and promoting the cause to which both the Association and the JOURNAL are devoted—the advancement and diffusion of science.

The Association took another important step in establishing a section of physiology and experimental medicine. Since the foundation of the Association and even since the division into sections eighteen years ago a group of sciences has developed with remarkable activity. Physiology, experimental psychology, anatomy, embryology, histology, morphology, pathology, bacteriology and their applications have hitherto been ignored by the Association. Yet they represent one-half of the work of the German Association. An increase in membership and a new impetus will undoubtedly follow the recognition of sciences whose great advances and beneficent influences are seen on all sides.

The lengthening of the term of service of the treasurer to five years was the only other amendment made to the constitution. This was an obvious improvement, the treasurer being as a matter of fact a permanent officer, though he has hitherto been elected from year to year. Several important recommendations were made by the Council, an account of which will be found in the report of the general secretary published below.

It is a cause for congratulation that the permanent funds of the Association were increased last year by over forty per cent. Mr. Emerson McMillin's qualification as a patron provided $1000, and the permanent secretary was able to hand over to the treasurer $1500, of which $500 resulted from the falling in of the dues of life members, and $1000 represented savings due chiefly to the efficiency of the permanent secretary. He was able to add a further sum of $1000 at the present meeting. In spite of this increase, certainly great when recorded as a percentage of the accumulation of many years, the permanent funds are lamentably small. Only when 100 patrons, each contributing $1000, have been secured will the Association be able to make appropriations for research equal to those of the British and French Associations.

The small amount available, the interest on the permanent funds amounting to $233, was used in the way most likely to produce valuable results and strengthen the Association. It was divided among four committees, to be spent under their auspices in special researches. The committees are: on anthropometry; on the quantitative study of biological variations; on the cave fauna of North America, and on the relation of plants to climate. When it is generally known that the small sum of $50 a year will provide for a research under the auspices of a committee of the Association it seems certain that the money needed will be forthcoming.

In accordance with a good departure the general committee at Columbus, in selecting New York as the place of meeting for the present year, recommended Denver for next year, and this recommendation was unanimously adopted. Invitations of great cordiality were presented, and it was the general opinion that an 'American' Association should meet farther to the west than hitherto. A good meeting at Denver is certain, while at the same time the influence of the Association will be exerted in a region

where educational and scientific institutions are making extraordinary advances. Pittsburg was recommended as the place of meeting in 1902. The president was elected by a unanimous vote of the general committee. It was the opinion of all that no one so well deserved this honor as Professor Charles Sedgwick Minot, of the Harvard Medical School, eminent in the great group of sciences now first recognized by the Association, as well as in his labors on behalf of the Association.

PROCEEDINGS OF THE ASSOCIATION.

The forty-ninth annual meeting of the American Association for the Advancement of Science began with the meeting of the Council at the Hotel Majestic at noon on Saturday, June 23d, and the first general session of the members was held at Columbia University at 11 o'clock on Monday, June 25th. The meeting was called to order by the retiring president, Mr. G. K. Gilbert, of the U. S. Geological Survey, who introduced the president-elect, Professor R. S. Woodward, of Columbia University. President Low welcomed the Association to New York City and to Columbia University and Professor Woodward replied. These addresses are published in this number of Science. Governor Roosevelt having telegraphed that he was unable to be present owing to important engagements, the Hon. James Wilson, Secretary of Agriculture, was called upon, and made an address emphasizing the importance of applied science, to which the Department of Agriculture is contributing so much.

On the adjournment of the general session, the sections organized and in the afternoon the addresses of the vice-presidents were given. There were only five of these, the addresses by Mr. J. A. Brashear, Professor C. B. Davenport, Mr. A. W. Butler and Professor C. M. Woodward having been postponed until next year in accordance with the plan that will hereafter be followed of having the addresses given by the retiring, instead of by the incoming vice-presidents. The addresses given at New York, now in course of publication in this Journal, are as follows:

Section of Mathematics and Astronomy: 'The Teaching of Astronomy in the United States,' by Professor Asaph Hall, Jr.

Section of Physics: 'The Kathode Rays and some related Phenomena,' by Professor Ernest Merritt.

Section of Chemistry: 'The Eighth Group of the Periodic System and some of its Problems,' by Professor Jas. Lewis Howe.

Section of Botany: 'Some Twentieth Century Problems,' by Professor William Trelease.

Section of Geology: 'Precambrian Sediments in the Adirondacks,' by Professor J. F. Kemp.

On Tuesday evening the members of the Association were welcomed to the American Museum of Natural History by President Jesup, and Mr. Gilbert gave the address on 'Rhythms and Geologic Time' published in the last number of this Journal.

The scientific work of the meeting was presented before the nine sections of the Association and the fifteen affiliated societies meeting with it, and will be reported fully in subsequent issues of this Journal.

The number of members and fellows in attendance at the time of the last general session was 447, which during the day was probably increased to slightly over 450. Different sections of the country were represented as follows: New York by 184 members; District of Columbia, 47; Massachusetts, 46; Pennsylvania, 32; Ohio, 22; New Jersey, 17; Indiana, 13; Connecticut, 12; Wisconsin, 10; Michigan, 9; Illinois, 8; Rhode Island, 7; Maryland, 6; New Hampshire, 5; Virginia, 4; three each from Canada, Missouri and North Carolina; two each from Iowa, Kentucky, West Virginia, Maine, Mississippi, Florida, Minnesota and Colorado; one each from Alabama, Tennessee, Kansas, Louisiana, South Dakota, California, Texas, Nebraska, Delaware and South Carolina.

Two hundred and fifty-nine new members were elected at the meeting, which, including those elected at previous meetings of the Council, makes a total of 331 new members since the Columbus meeting. It was announced by the Permanent Secretary at the close of the meeting that the membership list numbers 1900.

Seventy-seven fellows were elected as follows:

H. C. Lord, Ohio State University, Columbus, O.

E. S. Crawley, University of Pa., Philadelphia.

George A. Hill, U. S. Naval Observatory, Washington, D. C.

William J. Humphreys, Charlottesville, Va.

Miss Mary W. Whitney, Vassar Observatory, Poughkeepsie, N. Y.

Paul S. Yendell, Dorchester, Mass.

Arthur L. Foley, Indiana University, Bloomington, Ind.

Oscar M. Stewart, Cornell University, Ithaca, N. Y.

Barry McNutt, Lehigh University, South Bethlehem, Pa.

C. E. Mendenhall, Williams College, Williamstown, Mass.

Chas. F. Cox, Grand Central Station, New York, N. Y.

John F. Mohler, Dickinson College, Carlisle, Pa.

D. B. Brace, University of Nebraska, Lincoln, Nebr.

Wallace C. Sabine, Harvard University, Cambridge, Mass.

Chas. F. Scott, Westinghouse Co., Pittsburg, Pa.

Chas. T. Knipp, University of Indiana, Bloomington, Ind.

Chas. A. Perkins, University of Tennessee, Knoxville, Tenn.

A. DeF. Palmer, Brown University, Providence, R. I.

Frank A. Wolff, Jr., Columbian University, Washington, D. C.

George F. Stradling, Central High School, Philadelphia, Pa.

James S. Stevens, University of Maine, Orono, Maine.

R. W. Wood, University of Wisconsin, Madison, Wis.

Augustus Strowbridge, University of Michigan, Ann Arbor, Mich.

C. E. St. John, Oberlin College, Oberlin, Ohio.

Herschel C. Parker, Columbia University, New York, N. Y.

Thomas Clarke, Chapel Hill, N. C.

Miss Mary E. Pennington, Woman's Medical College, Philadelphia, Pa.

W. R. Whitney, Mass. Inst. Tech., Boston, Mass.

M. T. Bogert, Columbia University, New York, N. Y.

E. C. Franklin, Kansas State University, Lawrence, Kansas.

J. B. Weems, Iowa Agr. College, Ames, Iowa.

Samuel Bookman, Pathological Institute, New York, N. Y.

C. W. Moulton, Vassar College, Poughkeepsie, N. Y.

J. A. Deghuee, Brooklyn, N. Y.

A. W. Smith, Case School, Cleveland, Ohio.

C. W. Dabney, University of Tennessee, Knoxville, Tenn.

A. P. Saunders, Hamilton College, Madison, N. Y.

F. A. Genth, Lansdowne, Pa.

A. J. Hopkins, Amherst College, Amherst, Mass.

L. H. Orleman, Military Academy, Peekskill, N. Y.

W. O. Crosby, Mass. Inst. Tech., Boston, Mass.

F. P. Gulliver, St. Marks School, Southboro, Mass.

J. V. Lewis, Clemson College, S. C.

Edward Orton, Jr., Ohio State Univ., Columbus, Ohio.

W. G. Tight, Granville, Ohio.

S. Prentiss Baldwin, Cleveland, Ohio.

G. H. Barton, Cambridge, Mass.

S. W. Beyer, Iowa Agric. College, Ames, Iowa.

A. P. Brigham, Hamilton, Madison Co., N. Y.

H. C. Bumpus, Brown University, Providence, R. I.

Mrs. S. H. Gage, Cornell Univ., Ithaca, N. Y.

W. H. Welch, Medical School, Johns Hopkins Univ., Baltimore, Md.

Dean C. Worcester, U. S. Commissioner, Manila, P. I.

C. Hart Merriam, Dept. Agric., Washington, D. C.

E. B. Wilson, Columbia Univ., New York, N. Y.

G. S. Hopkins, Cornell University, Ithaca, N. Y.

Outram Bangs, Boston, Mass.

Frank Smith, Univ. of Illinois, Urbana, Ill.

A. G. Mayer, Museum Brooklyn Institute, Brooklyn, N. Y.

L Schoney, New York, N. Y.

C. L. Edwards, Trinity College, Hartford, Conn.

W. F. Ganong, Smith College, Northampton, Mass.

Wm. L. Bryan, Indiana Univ., Bloomington, Ind.

G. G. MacCurdy, Yale Univ., New Haven, Conn.

J. Walter Fewkes, Bureau of Ethnology, Washington D. C.

A. F. A. King, Washington, D. C.

F. R. Rutter, Dept. Agric., Washington, D. C.

George A. Hoadley, Swarthmore College, Swarthmore, Pa.

W. M. Stine, Swarthmore College, Swarthmore, Pa.

H. J. Webber, Dept. Agr., Washington, D. C.
Frank Wm. Rane, Agricultural College, Durham, N. H.
S. A. Beach, Agl. Exp. Station, Geneva, N. Y.
B. M. Duggar, Cornell University, Ithaca, N. Y.
A. D. Selby, Agl. Exp. Station, Wooster, Ohio.
Grace E. Cooley, Ph.D., Wellesley, Mass.
Oscar Loew, U. S. Dept. Agr., Washington, D. C.
John Muir, Martinez, Cal.

The more important transactions of the Council are the following:

A committee was appointed consisting of Professor Simon Newcomb, Mr. G. K. Gilbert, Professor R. S. Woodward, Professor Jas. Lewis Howe and Dr. L. O. Howard, to report upon the relations of the Association and the journal Science, and drew up the following resolution, which was unanimously adopted by the Council:

That the Council accept the proposal of The Macmillan Company to furnish the journal Science to all members of the American Association in good standing, at the rate of two dollars per year each; to take effect for one year from January 1, 1901, the total amount of the subscription at this rate to be paid by the permanent secretary from funds in his hands, and the members to receive the journal free of charge to themselves on the following conditions: That to the words of the title of the journal be added the words, 'Publishing the official notices and proceedings of the American Association for the Advancement of Science,' and that the price to all non-members of the American Association for the Advancement of Science be maintained at five dollars per annum.

That the President of the Association, the Permanent Secretary and one other member to be appointed by the chair be a committee with power to arrange details with The Macmillan Company.

The Committee composed of G. K. Gilbert, R. S. Woodward, F. W. Putnam, J. McK. Cattell and L. O. Howard, appointed at the April meeting of the council to consider the organization of an American branch of the International Association for the Advancement of Science, Arts and Education reported as follows:

That the Committee approves the idea of international co-operation in the field of science and recommends that the council designate a delegate to a national conference looking to that end.

The Committee on the disposal of back volumes of proceedings, consisting of G. K. Gilbert, L. O. Howard and T. H. Norton, reported as follows:

Your committee appointed at the New Haven meeting to consider the disposal of accumulated back numbers of proceedings, having given the matter due consideration, report the following recommendations:

1. That the back volumes now in storage in Cambridge be transported to New York and stored in the Columbia University at no storage cost to the Association.

2. That 50 complete sets be reserved for sale only in sets at 50 cents per volume.

3. That other back volumes, not less than five years old be sold to members for 50 cents each.

4. That volumes published within five years be sold at $1.50 each with the usual trade discount of 25 per cent.

The Library Committee reported and two of the members, Drs. T. H. Norton and Alfred Sprenger, resigned. A committee on the disposition of the Association library was appointed, consisting of W J McGee, B. F. Thomas and L. O. Howard.

A committee, consisting of John M. Clarke, W J McGee, J. McK. Cattell, Chas. H. Hitchcock and Theo. Gill was appointed to report on the erection of a bronze tablet to mark the house in Albany where the geologists of New York in 1838 met to make arrangements for the Association of American Geologists, the parent-body of the American Association for the Advancement of Science.

The committee of Section H, on the teaching of anthropology, was made a standing committee of the Association. It consists of W J McGee, G. G. McCurdy, Frank Russell, Franz Boas and W. H. Holmes.

Dr. Thomas Wilson reported progress on behalf of the Committee appointed to obtain legislation looking to the protection and preservation of many articles of archæological, ethnological and anthropological interest and value.

The action of the American Chemical

Society strongly recommending the establishment of a National Standardizing Bureau in Washington by the government was endorsed.

At the request of Section G, the following was adopted:

Resolved, That the American Association for the Advancement of Science, recognizing the importance of the preservation in its original condition of some portion of the hard-wood forests of the Southern Appalachian region, respectfully petitions Congress to provide for the establishment in that region of a National Forest Reserve.

The action of the same section in adopting the resolution given below was approved:

WHEREAS, the Pacific Coast redwood forests (*Sequoia Sempervirens*) are now practically all in the hands of private owners, who hold them for lumbering purposes; and

WHEREAS, this species occupies a certain coast-range belt of remarkable climatic characteristics, the study of which ought to be of profound interest to science; and

WHEREAS, the only other living *Sequoia* (usually known as *Sequoia gigantea*) which the redwood rivals in its proportions as well as in its interest to travellers and to men of science, has already received protection in part from the United States, by the establishment of the Sequoia National Park and the General Grant National Park, in the Sierra Nevadas;

Resolved, that the Botanical Section of the American Association for the Advancement of Science strongly approves the recent efforts of the several societies, clubs, colleges, universities and private citizens in California to create a public opinion that will result in the purchase and permanent preservation as a public forest park, of a tract of over 25,000 acres, largely made up of the primeval redwood forest, situated in the Santa Cruz mountains, forty miles southeast of San Francisco and fifteen miles south of the Leland Stanford Jr. University.

The reports of those to whom grants for research were made at the Columbus meeting, approved by the proper sections and accepted by the Council, were as follows:

REPORT OF THE COMMITTEE ON THE STUDY OF THE WHITE RACE IN AMERICA.

The Committee on the study of the white race in America report that in accordance with the plans proposed at the Columbus meeting they have made arrangements to carry out physical and mental tests on members of the Association at the present meeting, and these are now being made. A report on this work and on work of an anthropometric character done under the auspices of this committee and elsewhere has been made to Section H at its Christmas meeting and at the present meeting, and it need here only be remarked that the measurements of our members will be of special interest when compared with those of members of the British Association. In view of the fact that instruments were at hand at the place of meeting this year it was not necessary to purchase them, but if the work is continued it will be necessary to secure a set of instruments that will be the property of this Association and can be sent from place to place. We ask for this purpose an appropriation of $50 to be added to the similar appropriation made last year. We ask that the name of the Committee be changed to Anthropometric Committee, thus limiting and defining more exactly its scope. We ask that the vacancy on the Committee caused by the death of Dr. Brinton be filled by the appointment of Professor Joseph Jastrow.

J. MCK. CATTELL.
F. BOAS.
W J MCGEE.

REPORT OF THE COMMITTEE ON THE QUANTITATIVE STUDY OF BIOLOGICAL VARIATION.

The Committee has held two meetings. The first took place at New Haven during the Christmas recess, Drs. Boas, Cattell and Minot being present. At this meeting it was planned to prepare a report on the course of study which should be pursued in preparation for quantitative work in variation, and on the instruction now given in variation in colleges. It was proposed also to present a report on the history of the development of the quantitative study of variation. This report has been prepared by the recorder and read before Section F. The second meeting of the Committee was held at the Hotel Majestic, New York, June 25, 1900. Present, Drs. Cattell, Eigenmann and Davenport. At this meeting a summary of the results got by Mr. C. C. Adams, to whom the grant of $50 was made, was received. The full report of Mr. Adams is to be presented to Section F. As Mr. Adams has not yet completed his studies it was voted: To recommend that, if possible, one hundred dollars be appropriated to the Committee on the Quantitative Study of variation to aid Mr. C. C. Adams in his further researches on the variation of the genus Io. In case it is not feasible to appropriate so large a sum the Committee recommends that so much as possible be granted.

The Committee asks to be continued.

F. Boas,
C. S. Minot,
J. McK. Cattell,
C. H. Eigenmann,
C. B. Davenport, *Recorder.*

REPORT ON THE INVESTIGATION OF THE BLIND VERTEBRATE FAUNA OF NORTH AMERICA.

In the absence of a committee I beg leave to make the following personal report on the grant of $100 made me for investigation of the blind vertebrate fauna of North America.

1. Collections of typhlogobins were made at the foot of Point Loma, Cal.

2. A collection of 12 Rhineura was secured through dealers.

3. Mr. E. B. Forbes visited southwestern Illinois and secured a series of chologasters at what I had supposed to be their breeding time.

4. Six trips were made to Mitchell, Indiana, caves to secure embryological material.

5. One trip was made to the Mammoth Cave region in Kentucky.

6. A visit was made to the San Marcos, Texas, wells and caves.

7. In most cases the railroad companies granted either passes or half rates to the points mentioned. The total expenses of these trips chargeable to the appropriation were $139.66. An appeal was made to the Trustees of the Indiana University to pay as liberal an amount of these expenses as possible. An appropriation, the amount of which I have not yet ascertained has been granted by them so that a balance of the Association grant is still available.

The results obtained during the year were embodied in the paper presented during the meeting of of Section F on June 26th.

To assist in the continuation of the work in hand I will recommend that a committee be appointed to direct the work. I hope that a small additional grant be made for the use of the committee during the year.

C. H. Eigenmann.

The Committee on Grants made the following recommendations to the Council and they were adopted:

1. That a grant of $50 be made to the Committee on anthropometry.

2. That a grant of $50 be made to the Committee on the study of blind vertebrates.

3. That a grant of $100 be made to the Committee on the quantitative study of biological variations.

4. That a committee be appointed to study the relation of plants to climate, and that a grant of $33 be made to such committee.

5. That if practicable an allotment of $17 be made to the last named committee from the funds in the hands of the permanent secretary.

The two new committees to which grants were made were appointed as follows:

'On the Study of Blind Vertebrates': Theodore Gill, *Chairman*; A. S. Packard, S. H. Gage, C. O. Whitman, H. C. Bumpus, C. H. Eigenmann, *Secretary.*

'On the Relations of Plants to Climate': W. M. Trelease, D. T. McDougal, J. M. Coulter.

The Treasurer in his report for the year ending December 31, 1900, showed that the permanent funds in his hands at the beginning of the year were about $6083, which were increased during the year by about $2733, making the total about $8817. The receipts represented $1000 from Mr. Emerson McMillin as patron, $500 from fees of deceased life members, $1000 in addition from the permanent secretary and about $233 interest. The permanent secretary in his financial report showed a balance from his preceding account of $3723.90 and a balance carried forward to the new account of $4228.33. The receipts were $6216 from members and $172.49 from miscellaneous sources. The expenditures in addition to the $1500 handed over to Treasurer were: Publications, part of Boston volume, $1003.33; Expenses, Columbus Meeting, $427.54; General Office expenses, including expressage and postage on Proceedings, $931.19; Salaries, $1970; Miscellaneous disbursements, $52.

The general session met daily. It passed resolutions in memory of Dr. Edward Orton, who died during his term of office as president, and adopted amendments to the constitution establishing a Section of Physiology and Experimental Medicine and extending the term of office of the treasurer to five years. Amendments to the Constitution, which lie over until next year, were proposed, making the presidents and secretaries of the affiliated societies members of

the Council, establishing a section of Commerce and Manufactures, and giving the Council, under certain conditions, power to change the place and time of meeting.

At the last general session it was announced that the general committee had elected officers for next year as follows:

President.

Professor Charles Sedgwick Minot, Harvard Medical School.

Vice-Presidents.

Mathematics and Astronomy: Professor James McMahon, Cornell University.

Physics: Professor D. D. Brace, University of Nebraska.

Chemistry: Professor John H. Long, Northwestern University.

Mechanical Science and Engineering: Professor H. S. Jacoby, Cornell University.

Geology and Geography: Professor C. R. Van Hise, University of Wisconsin.

Zoology: President D. S. Jordan, Leland Stanford Jr. University.

Botany: B. T. Galloway, U. S. Department of Agriculture, Washington, D. C.

Anthropology: J. W. Fewkes, Bureau of Ethnology, Washington, D. C.

Economic Science and Statistics; John Hyde, Department of Agriculture, Washington, D. C.

Permanent Secretary.

L. O. Howard, U. S. Department of Agriculture, Washington, D. C.

General Secretary.

Professor William Hallock, Columbia University, New York.

Secretary of the Council.

D. T. McDougal, New York Botanical Gardens.

Secretaries of the Sections.

Mathematical and Astronomy: Professor H. C. Lord, Ohio State University.

Physics: J. O. Reed, University of Michigan.

Chemistry: Professor W. McPherson, Ohio State University.

Mechanical Science and Engineering: William H. Jacques, Boston, Mass.

Geology and Geography: Dr. R. A. F. Penrose, Pierce, Arizona.

Zoology: Professor H. B. Ward, University of Nebraska.

Botany: A. S. Hitchcock, Manhattan, Kansas.

Anthropology: G. G. McCurdy, Yale University.

Economic Science and Statistics: Miss C. A. Benneson, Cambridge, Mass.

Treasurer.

Professor R. S. Woodward, Columbia University.

Denver was selected as the place of meeting for next year, and Pittsburg was recommended for 1892. The meeting next year will begin with the session of the council on Saturday, August 24th, and the scientific work will begin on Monday, August 26th.

CHARLES BASKERVILLE,
General Secretary.

ADDRESS OF WELCOME.

PRESIDENT LOW, of Columbia University, said: Mr. President and Members of the American Association for the Advancement of Science: It gives me very much pleasure to welcome this Association to the City of New York and to Columbia University. It is thirteen years since this Association met in the City of New York, although it met I believe in 1894 in the City of Brooklyn which has since become a part of this city. In that interval of thirteen years there has been a profound stirring of the scientific spirit in this vast community. Witness, if you please, the foundation of the Botanical Garden of New York by the co-operation of the City and of private organizations, after the pattern which has shown itself so effective in the case of the Metropolitan Museum of Art and of the American Museum of Natural History. Witness again, the formation of the New York Zoological Garden which is projected upon a scale entirely worthy of this great metropolis; witness the establishment by the City authorities of the Aquarium; witness the enlargement, until it is three-fold its size of thirteen years ago, of the American Museum of Natural History; all of these things being done either by the City itself as in the case of the Aquarium, or by the City in co-operation with private agencies as in all the other cases. The Universities of

the City have made immense strides in the direction of scientific equipment in the same interval. Our own University, New York University and the Medical Schools attached to these two universities and to Cornell University and to the Long Island Medical College, all of them only thirteen years ago practically without laboratory equipment, all of them to-day equipped in a way to compare favorably with medical schools in any part of the country and in some respects, perhaps, favorably with medical schools in any part of the world. The scientific societies of New York have also awakened to new life. All these things show that throughout the length and breadth of this vast community a remarkable stirring of the scientific spirit has occurred since your last meeting here. It may easily be that your meeting here at that time sowed the seeds, or some of the seeds at least, which have produced this valuable and welcome fruit. I congratulate you upon securing for the advancement of science such an ally as this metropolitan city. It has indeed the strength of a giant, and, once aroused, it brings to any cause to which it allies itself a giant's strength. Therefore, I congratulate you, as I have said, in obtaining for the cause which appeals to you so important an ally as the City of New York.

I think I may also say that this University, which to-day welcomes you as its guest, has had its fair share in the reawakening. In 1887, when you were here, my predecessor, the late Rev. Dr. Barnard, was president of this University; when he died, a year or two later, it was found that he had left his entire estate to the University, subject to a life interest on the part of his widow, with the provision that $10,000 should be set apart for the maintenance of a Barnard fellowship in science, to be awarded to some fellow who should pursue physical and chemical research. He provided also for the award, every five years, of the 'Barnard medal for meritorious service to science.' This medal is awarded by the Trustees of the University upon the recommendation of the National Academy of Sciences. It was given this month to Professor Roentgen for the discovery of the X-rays. The remainder of Dr. Barnard's estate, he provided, should be a fund for the increase of the Library, the income of which should be used especially for the purchase of scientific books, and more especially in the domain of physics and of chemistry. When Mrs. Barnard died, a year or two later, it was found that she had added her own estate to that of her husband and dedicated it to the same purposes. I think it is interesting to find that our late president should have had the cause of science so near at heart, for he was, as many of you know, a clergyman of the Episcopal Church; but he was one of those who saw no contradistinction between the Truth of God written in the manuscripts of Nature, and the Truth of God as revealed through the Scriptures. In that respect he was a worthy representative of the University whose motto has been, since its foundation in 1754, "In Thy light we shall see light." Therefore we anticipate new discoveries in science, because at the center of all things, we believe, is the Father of Light. In 1887 this University studied science and taught science. It had not, however, committed itself to the advancement of science, as in the interval it has done, by the establishment of its Faculty of Pure Science. I remember that when Professor Osborn was invited to the chair of biology, in this University, he told me that only a few years before he had wanted to study that science in the City of New York, and could find no opportunity. There was then no provision, either public or private, for the study of biology in this great metropolis. You know as well as I how great is the change to-day.

Any cause which is sufficiently great to attract delegates from all over the United States every one recognizes as a cause of importance. The fact that, from so wide a territory, men and women will come together to discuss that interest stamps it as an interest of unusual importance. This meeting lacks no element of importance in that regard. Not only does the Association for the Advancement of Science gather its representatives from all parts of the Union, but there are also meeting with you this week at least fifteen affiliated societies; and I believe all of them are national in their scope. But after all, this meeting interests me, less because of the wide range of territory from which it gathers its adherents than from the vast range covered by its interests. Here are men and women whose itnerests reach out through the entire universe. Occupied space, so far as its occupancy can be made known either by photography or by the spectroscope, is included naturally within the range of your interest. On the other hand, you deal with the little things of the universe as carefully as with the great things. Here are those who are interested in all life, whether human or of any other kind. Here are those who are interested in inanimate objects, whether great or small. The interests which you have come to serve are not national in their scope only, nor international, nor world-wide—they are universal; and it seems to me that this fact itself is an interesting illustration of the unity of Nature. No one can study any part of the natural universe without being drawn into the current with those who are studying the universe in some other part.

But I should fail, it seems to me, to do justice to your Association if I did not as President of this University, recognize the immense contributions of science to the cause of education. I suppose there is hardly a lecture room in this building in which preparation is not made for the use of the electric lamp, so that through the use of electricity and photography almost every branch of scientific research is being forwarded. The student can sit in his room, and see whatever the sun sees; he can see what the sun never saw, because the sun is blinded by the fullness of its own light; he can see what exists in the outer universe and also in the depths of the earth. But this is not the greatest contribution science has made to education. After all, it is, in all these things, the unseen rather than the seen that is the essential. I should say that science has contributed to education in the last half century two things vastly more important than all its contributions to the better equipment of the class room. It has given to us the evolutionary theory; which, being applied in almost every domain of study, has revolutionized it; and it has given to us, also, the scientific method. I stated to you that thirteen years ago there was hardly a laboratory in the City of New York in connection with an educational institution. There were chemical laboratories and assay laboratories, here and there, but almost no others. Even the public schools of the City are equipped with laboratories in several sciences at the present time. So that in those two gifts—the evolutionary theory and the scientific method, you have made contributions which certainly demand the most generous recognition on the part of educators. In making this statement I am sure that I speak, not only for this University, but for every university in the land.

I am especially glad to welcome you because you are an Association for the *Advancement* of Science. That, after all, is what ought to make you feel at home in the atmosphere of this University; for a university that does not assist the advancement of science has hardly a right to call itself by that great name. I heard Phillips Brooks

say, in a sermon that I heard him preach in Boston when this Association met there 20 years ago, that you can get no idea of eternity, by adding century to century or by piling æon upon æon; but that, if you will remember how little you knew when you sat at your mother's knee to learn the alphabet, and how with every acquisition of knowledge which has marked the intervening years you have come to feel, not how much more you know but how much more there is to be known, all can get some idea of how long eternity can be, because all can understand that there never can be time enough to enable any one to learn all that there is to know. There is so much to be known, that even the great advances of the last generation do not make us feel that everything is discovered, but they appeal to new aspirations and awaken renewed energy in order to make fresh discoveries in a region that teems with so much that is worthy of knowledge. I congratulate you upon your success, and I bid you welcome to Columbia.

ADDRESS OF THE PRESIDENT.

Professor Woodward said: Under the favorable auspices of this institution of learning, with its commodious quarters and its scientific atmosphere so generously placed at our disposal, we meet to-day to begin the forty-ninth session of the American Association for the Advancement of Science.

The life of this Association has been contemporaneous with an epoch of triumphant scientific progress; and in this last year of the century one is tempted to look back into the history of the achievements of our predecessors, in order to render them due homage, and in order to learn from their experience the wisdom essential for future guidance. One is prone especially to recall the noble lives and the indefatigable industry of the founders and early workers of this Association, who are no longer with us, but whose careers are sources of admiration and inspiration to the present generation of scientific men in America. There were Rogers and Henry and Bache, and Agassiz and Peirce and Dana, and Torrey and Hall and Lea, and Barnard and Gould and Gray, and Marsh and Dawson and Newton, and Brinton and Cope; and many others not less worthy, whose life work was intimately related to the work of this Association. The mere mention of a few of these honored names may suffice, however, on this occasion, to remind us of our indebtedness to them, and to assure us of the steady progress which has attended the Association in its growth from a single section of a half century ago to the nine different sections and twice as many affiliated societies of to-day. The fertility of the study of our planet in stimulating thought and in leading thought to action is at once apparent when we recall that out of the small beginnings of a few naturalists who styled themselves the American Geological Society have sprung the varied activities of this Association and the kindred societies which meet with us this week. Verily we may say, in the noble words inscribed over the entrance to Schermerhorn Hall on our right, "Speak to the earth and it shall teach thee."

But science knows no nationality, and the forward movement in which our Association is engaged is only a part of a world wide advance which is undoubtedly the most noteworthy characteristic of the civilization of the present half century. And wherein, we may fittingly ask ourselves, and still more fittingly may the general public ask us, does this advance consist? What, in common parlance, are the contributions which the science of our day has brought to the betterment of man's estate? In a summary way, disregarding material

benefits, which everybody recognizes, these contributions may be specified under three heads in the order of their historical succession.

First, there is the far-reaching generalization known as the law of conservation of energy, whose establishment dates from about 1850. This law holds in what for the present we find it convenient to call the material world. It enables us to describe what goes on in that world in the simplest terms and in the most comprehensive fashion. It relates unknown to known phenomena; and it enables us to predict with practical certainty not only the feasibility and efficiency of the vast aggregate of mechanical appliances on which the continuity of daily life now depends, but also the range and limitations of the physical processes of the entire visible universe. This doctrine supplies at once the principal criteria of, and the principal methods of investigation in, physical science. It is the most precise and the most comprehensive of theories devised by man.

Secondly, there is the doctrine of evolution, which dates substantially from the publication of Darwin's work on the Origin of Species in 1859. This, like the doctrine of energy in the material world, enables us to describe in the simplest terms and in the most comprehensive fashion the succession of events in what for the present we find it convenient to call the organic world. It enables us to trace the lines of development along which life has proceeded from age to age in geologic time, and to predict with some degree of probability the course and order of development in the future. It enables us to see how in the endless interactions of the organic and inorganic worlds, the former is adapted to the latter and the latter is moulded by the former; so that the history of terrestrial life, with its teeming forms of animal and vegetable organisms, becomes, in the light of this doctrine, at once readable and verifiable. But the law of evolution is not limited in its application to the lower forms of life alone. It extends to man as well, and proclaims him a part of, and not apart from, the world of phenomena we seek by scientific methods to explain. Thus, with the advent of this doctrine, the anthropocentric theory of the universe, so long held by man, vanishes; but by way of compensation, if any were needed, the new view of his rôle confronts him with the transcendent problem in which the instrument of investigation is, in a far higher degree than hitherto, the object of research.

Thirdly, and perhaps most important of all, there is the educational renaissance which seems to be a direct result of the increase and diffusion of science in our times. Learning is no longer restricted to a narrow range of subjects. Studies are no longer strictly divisible into those which are liberal or humanistic, and into those which, *per contra*, must be illiberal or demoniacal; and the value of knowledge is no longer measured by linguistic standards alone. In short, we have come to understand the essential unity of knowledge and the universality of its sources; and that progress is attained not so much by journeying along the easy highway of *à priori* reasoning as by following up the rough trails of observation and experiment. So rapidly and completely has this renaissance come about that many of the present generation are quite unable to understand how educational affairs could have been at all different in the preceding generation. That liberal provision should be made for the teaching of science in every school, and especially in every college and university, now goes without saying; and munificent endowments for the maintenance of scientific instruction and investigation are everywhere the order of the day. But it was not very long ago—quite within a stretch of the

recollection of many here present—when science was an unknown quantity in our common schools and a sort of imaginary quantity in our colleges. The average school boy's idea of science, as Huxley says in one of his earlier essays, was that it meant 'skill in boxing.' One professorship in a college was commonly comprehensive enough to include all the sciences, and frequently too comprehensive for the peace of college faculties; for, strange as it now appears to us, some of the growing sciences were looked upon as threatening the stability of the social fabric, and all were regarded as dangerously aggressive. Laboratories were either wholly wanting or little used; and although most students gained the idea that all that is worth knowing was ascertained long ago and is to be found in books, libraries seemed to be maintained for the sole benefit of librarians and bookbinders. These were the good old times when the college professor heard recitations by day and read polite literature by night.

It is matter of history that the educational progress of the past three decades has not been accomplished without an intellectual struggle, the noise of which is still heard, occasionally, in the wail of those who fear that the treasures as well as the rubbish of the golden age of antiquity may be engulfed by the iconoclasm of the present age of steel. But whatever may have been our prepossessions, as we look back on this struggle, with our senses of proportion and humor not overstrained by the pressing nearness of events, there appears little cause for regret. The emancipation of education from the dominance of classical tradition is seen to be merely an incident in the general advance. Whatsoever is worthy and noble in the ancient learning has acquired new and increasing interest in the light of the growing science of anthropology; and whatsoever is unworthy and ignoble may well wither in the light of modern criticism.

But surprising and gratifying as have been the achievements of science in our day, their most important indication to us is that there is indefinite room for improvement and advancement. While we have witnessed the establishment of the two widest generalizations of science, the doctrine of energy and the doctrine of evolution, we have also witnessed the accumulation of an appalling aggregate of unrelated facts. The proper interpretation of these must lead to simplification and unification, and thence on to additional generalizations. An almost inevitable result of the rapid developments of the past three decades especially is that much that goes by the name of science is quite unscientific. The elementary teaching and the popular exposition of science have fallen, unluckily, into the keeping largely of those who cannot rise above the level of a purely literary view of phenomena. Many of the bare facts of science are so far stranger than fiction that the general public has become somewhat overcredulous, and untrained minds fall an easy prey to the tricks of the magazine romancer or to the schemes of the perpetual motion promoter. Along with the growth of real science there has gone on also a growth of pseudo-science. It is so much easier to accept sensational than to interpret sound scientific literature, so much easier to acquire the form than it is to possess the substance of thought, that the deluded enthusiast and the designing charlatan are not infrequently mistaken by the expectant public for true men of science. There is, therefore, plenty of work before us; and while our principal business is the direct advancement of science, an important, though less agreeable duty, betimes, is the elimination of error and the exposure of fraud.

As we contemplate the future activities

of our Association, one of the interesting and inspiring signs of the times is seen in the increasing number of international conferences for the promotion of art, commerce, education, science, and, above all, peace and good will to men. At the joint meetings held last year by the British and French Associations for the Advancement of Science, steps were taken to form an international organization, which has since been perfected under the name of the International Association for the Advancement of Science, Art and Education. The first meeting of this body will be held during the present summer at the Paris Exposition. May we not entertain the confident hope that, under the influence of such an association, science, which has done so much to enlighten the minds and ameliorate the conditions of men during the nineteenth century, will play a still more beneficent rôle during the twentieth century?

And now, with a cordial invitation to our hosts, the Trustees, the President, and other representatives of this institution of learning, and with a like cordial invitation to the general public as well, to attend the sessions of the various sections of the Association, I declare this meeting formally open for the transaction of its regular business.

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*ON THE TEACHING OF ASTRONOMY IN THE UNITED STATES.**

HAVING to teach Astronomy at the University of Michigan, it has been necessary for me to make inquiries regarding the instruction in this subject given at other universities. I have tried to learn also the character of the work done at the different observatories, from the point of view of the development of students and the encouragement of the spirit of scientific research. Thus I propose to discuss briefly the position taken by our colleges, and observatories also, in the teaching of Astronomy.

Not so very long ago in this country of ours, which is rather new after all, many of the young men educated at the colleges were intended for the ministry. They were trained in Latin, Greek, Hebrew, and a little Natural Philosophy, as it was called, this latter subject including all the known sciences, and being taught by one man. There was almost no laboratory work. At present, whether for good or ill, the rule of the clergymen over our colleges is pretty well broken. The old style college president, usually a clergyman of scholarly tastes and sympathies, who teaches the seniors Moral Philosophy, is becoming rare. His place is being taken by the sharp business man, who in his scholarship corresponds very much to a librarian, having a wide knowledge, but not necessarily an accurate one on any subject.

Of late years the elective system has been introduced, and has been extended very far, so that a degree may represent almost anything, in many cases a good deal of technical and professional work being included. If a large number of students are to go to colleges it is necessary, probably, that the technical studies should be allowed to remain, as many would not have the means to give themselves a liberal education.

Of course, it is hard to discuss in a fair and intelligent way the intrinsic merit of Astronomy or any other study. I believe myself that students who can manage it ought to obtain something of a classical training. But in the case of any given student who elects Latin, for instance, is the subject really chosen for the culture which it gives? I must say that in most cases that I know about I can't tell. Sometimes I think that in college all studies

* Address of the Vice-President and Chairman of Section A—Mathematics and Astronomy—at the New New York Meeting of the American Association for the Advancement of Science.

ought to be elective with the exception of a moderate requirement in English, and that as regards mental discipline and culture one thing is about as good as another, if it is properly taught.

To begin with the elementary Astronomy, it seems to me that it should be taught in the high schools and preparatory schools as well as in the colleges. Preparatory work in it ought to be accepted for admission to college. By elementary Astronomy I mean those common, every-day facts of the science which can be learned by any intelligent student without mathematical training; for example, why the stars rise and set, the motions of the planets and the moon among the stars, the reason for the seasons, the names of the principal constellations and why they seem to change with the seasons. These are things that are before our eyes all the time, and every one who is fairly well educated ought to know something about them. I would not say that this Astronomy ought to be required for entrance to college, or required in college, but it certainly ought to stand on the same plane with Botany, for instance, and Zoology.

As a culture study in college I would bring to your notice also the history of Astronomy. The study of this science no doubt goes back to a time before we have any historical records, and probably was connected with religious worship and festivals. The motions of the sun, moon and planets were watched and studied. It was seen very soon that the seasons and crops and life on the earth depended on the sun's position in the sky. Thus the sun was worshipped as a god, giver of life and harvests. It may be that our Christmas is the remnant of an old pagan festival when rejoicing was had because now the sun would turn and go north and winter would leave the northern hemisphere, and vegetation and life would come back.

Therefore, in the earliest times Astronomy was studied a good deal by the priests. They kept the calendar and the dates of the religious festivals. They followed the motions of the sun, moon and planets, and knew that the planets sometimes advanced and sometimes retrograded in the sky. They had a considerable observational knowledge of the heavens. It is said the Chaldeans had a very exact calendar, better than ours, and giving only an error of one day in ten thousand years. They must therefore have known the length of the tropical year with great exactness.

It would be natural, too, for the sailors of the Mediterranean sea to have considerable practical knowledge of Astronomy. Much commerce was carried on this sea. The Phœnicians voyaged to Britain and Spain and Carthage. The Greeks had many distant settlements. The Romans had large navies, and sailed over all the Mediterranean and to Britain.

But I think one of the most interesting portions of the history of Astronomy would be the philosophical study of the different theories of the universe. Pythagoras is said to have taught the true system of the world, that the earth moves around the sun and at the same time turns on its own axis. But probably this was only one of the doctrines of the speculative Greek philosophers and it was soon abandoned.

It is a curious fact that the system of Ptolemy prevailed for fourteen centuries, and that the new ideas of Copernicus, Galileo and Kepler were so long in being adopted. This may have been because the natural vanity of the human race was appealed to by making the earth the center of the universe. The Ptolemaic theory had come to be supported also by the church, by the old Greek philosophy, and by all the weight of authority. The new theories of Galileo were opposed, no doubt, to the

hopes, fears and prejudices held at that time by mankind; his treatment by the church represented these and cannot be charged to any particular church. But it is a strange commentary on the fallibility of human authority and prejudice. Even now most people have little knowledge of the scientific method of experimentation.

As affairs are really conducted it is difficult to secure any readjustment of studies, since so much of practical college politics is involved. First it is necessary to secure a vote of the faculty, then the president appoints a committee, and a majority of the committee divides among itself anything there is in the way of profit. Thus, in the case of some studies a sort of endless chain arrangement has been established, the college requiring the subject for entrance and after entrance, and in that way being enabled to send out a large number of students to teach it. A number of High School teachers of Astronomy have told me that they were not able to obtain money for apparatus because the subject could not be offered for admission to College.

It would seem to me that all who had a long enough training ought to be encouraged to come to College, even though they may not have begun with that idea, but may have intended to stop with the High School. Therefore the number of subjects to be received for admission ought to be a pretty large one, so that the student may use any study that he has taken. The tendency is, I think, in this direction, as well as towards a greater freedom of choice of studies.

Regarding the Astronomy which is somewhat more advanced than the beginning work, as spherical Astronomy and the elements of celestial mechanics, these subjects might be more generally taught than they are at present, both as a part of a liberal education, and looking at them from a commercial point of view. I will explain what I mean by this latter phrase by taking the case of Latin again. For many students Latin is just as much a technical training as that of a bridge engineer. They do not care for it especially, but expect to teach it as soon as they graduate, and earn money, and they are obliged to look at the subject in that light.

Taking, then, what might be called a practical standpoint, some Astronomy is necessary in all surveying and geodetic operations, and a number of engineering schools and colleges offer courses in field work.

Most of the teachers of mathematics and physics in the small colleges are required to give instruction also in astronomy. It would be worth while for them to fit themselves to do this well, both in the use of instruments and in some of the mathematical theory. Also, in this present epoch of the function theory and higher algebra there is a real need of men who are qualified to teach applied mathematics. So many mathematical processes have been invented by the masters for the solution of astronomical questions, especially in differential equations and theoretical mechanics, that every teacher of applied mathematics ought to have some knowledge of astronomy.

Extended instruction in celestial mechanics is offered in few colleges. Not many men can be found who are qualified to teach it, and perhaps it is hardly advisable for the student to go very far unless he has special gifts in that direction. But it certainly requires a much higher order of ability to make advances in celestial mechanics than to execute what are ordinarily called scientific researches, and colleges that have the means ought to provide for the men of this superior ability. I dwell on this somewhat, as the difference is not very clearly understood between ordinary, routine, respectable work, and that which involves some distinct progress. Ability to do the latter is a gift with which a very few men are

born, just as there are very few good artists and good poets. Some of the best known and ablest scholars of the world have been those who have made substantial advances in celestial mechanics. I do not see why such men should not be supported and encouraged by the colleges as well as those who study Hebrew, for instance. The working out and discussion of the laws which govern our universe gives strength to a natural theology much more than does the study of Hebrew.

For extended instruction in practical astronomy and observatory work opportunities are now offered at a number of places in this country. Not many years ago it was difficult to obtain it. It was given regularly only at one or two places, and occasionally as a sort of personal favor by a working astronomer. Some twenty years back most of such teaching was done by Professor Stone, now of the University of Virginia. I think it is hardly understood how much he did in this direction, and how many men were once students with him who are now active in the science or have influential positions in the educational world.

The best equipped observatory for teaching purposes that I know of is at Princeton, built, I believe, under the direction of Professor Young. A number of other colleges have observatories, keep them up well, and offer good courses of instruction, both elementary and graduate. In the large astronomical establishments there is a tendency sometimes towards the factory system, which is to be regretted. But where the question is of obtaining the greatest amount of work from a given income, something of the kind may be unavoidable, though when carried too far it tends toward the extinction rather than the extension of research. I have been told that after he became an old man Sir George Airy regretted that he had introduced such a system at Greenwich.

However, at almost all the college observatories that I know of some attention is given to students. It is recognized that it is just as important to train men as to carry on investigations, the German view, and probably the result of so many of our young men going to Germany to study.

With regard to the part that government institutions ought to take in training students and the encouragement of original research, it is difficult to make a criticism. They are often engaged on pieces of heavy work, extending over long intervals of time which private establishments cannot undertake. It may be somewhat necessary to have this done in a routine way, without such regard to whether the computer or assistant is benefited or is making any progress in scholarship. The Naval Observatory is required, for instance, to keep up observations of the sun, moon and planets. However, some arrangement might be made to change assistants about and give them experience in every kind of investigation that is being carried on at any institution. It might be wise to appoint men on very small salaries at first, and allow them half their time for study.

It is interesting to look over the names of the men connected with the American Ephemeris in the early years of its history. I find Davis, Benjamin Peirce, Gould, Newcomb, Hill, Van Vleck, Runkle, Ferrel, and others who became well known in science. I have not had an opportunity to find out how the office was managed.

I have made some examination of the theses in practical astronomy produced in this country, and have attempted to compare them with those presented in Germany and France. On the whole I think we make a creditable showing. Perhaps our instruction is not so thorough and painstaking as that given abroad. There may be with us a tendency to be satisfied with making observations merely, without dis-

cussing them properly or attempting to derive the best results. For educational purposes I think too great emphasis cannot be given to the distinction between the two kinds of work I have referred to. That which is planned and carried out in a scientific way alone has value. No matter what skill one may have in observing or making photographs, if he cannot discuss his observations or photographs he stands very much in the relation of a skillful stonecutter to the architect of a building. Very many good photographers can be found in the galleries of our cities, men of great experience and skill, but most of them have no scientific standing and deserve none, though with a little additional experience they could make good astronomical photographs. It is true, also, that many theoretical problems can be solved without having much idea of the theory involved. Orbits are computed by men who do not know very well the meaning of the formulas which they are using. Questions in perturbations are worked out in the same way. Often good and useful results are thus obtained. But this technical skill in using instruments or handling formulas, though necessary, is not a faculty of the highest order. At the same time, however, it ought to be remembered that it is something very useful, and cannot be obtained to a high degree without years of experience.

In practical astronomy I should say that our model ought to be Bessel, that he combined in just the right proportion theoretical knowledge with skill in handling instruments and ability to obtain from an instrument the best results. Especially in relation to college instruction do I think it worth while to call attention to Bessel's papers.

It is true that men of ability will get on without teachers, and that teachers cannot furnish brains. But it is also true that a good teacher can be of very great help even to men of genius. We all have known such, uneducated or self-educated, who would have been helped very much, and been kept from bad blunders if they could have had some training. Encke, Argelander, Gould, Winnecke, Schönfeld, Brünnow, Watson, all studied with experienced astronomers, who are known by their students as well as by their scientific labors. Most of the men just mentioned were teachers, also, and probably left their impress upon the science to as great an extent through their teaching as through their scientific investigations.

It is worth while to take a book like Watson's 'Theoretical Astronomy,' and look over some of the articles, such as the theory of the computation of an elliptic orbit, and the theory of special perturbations, and then examine the treatment given by the different teachers, and see how these theories, after leaving the hands of Gauss, the great master, were modified somewhat by Encke, who was a student with Gauss, and finally by Brünnow and Watson, Brünnow having studied with Encke, and Watson with Brünnow. There is no doubt that Tisserand did a great service to Astronomy by publishing his 'Mécanique Céleste,' putting in a clear and elegant form the principal facts of Mathematical Astronomy, though it is hardly to be ranked with the making of important advances in the science itself.

I think that the standard of scholarship in this country is steadily becoming higher, and that we are having better opportunities for instruction in Astronomy as well as in the other sciences. For however much it may hurt our national vanity, the criticisms of such men as Henry James on our civilization are sound. We are a new country. Our first business has been to clear it up and make roads. We are a nation of business men, trades people. Commercial ideas control, to some extent, our college education, and we lack much that in older coun-

tries makes for the advancement of science and art. But time has changed this somewhat, and I think it will change it more.

With regard to all the sciences a large number of misstatements are made regarding their commercial value. Probably Astronomy has been of as much benefit to mankind as any. Every ocean passenger owes to it his safe and rapid passage. Through its help the carriage of every ton of freight is made cheaper. It would be difficult to calculate the money value it has been to the world.

The conception which most people have of the nature of the questions to be solved in Astronomy is a false one. They look on them as text-book problems in mathematics which are arranged to come out nicely. They suppose such questions can be solved definitely and exactly, once for all. They do not know that instruments are imperfect and that observers have personal errors, nor that it is possible to be sure only to a certain limit, personal opinion founded on experience carrying us a little farther, and the rest being uncertain, though methods and instruments and mathematical conceptions may, after a while, be improved. So that in any actual question in practical or theoretical Astronomy it is necessary to deal with facts as they are in nature, and obtain the best possible solution, though perhaps not the one which is exactly true.

Many people, too, and well educated ones, have very curious ideas as to the amount of labor involved in the solution of questions in Astronomy, and as to the progress of the science. An intelligent doctor, who knows that the science of medicine, as far as it is a science, is something of slow growth, who experiments for a year or two on some fairly simple question, cannot understand the same thing in Astronomy, and thinks that it was really founded and developed by some one whom he happens to know about.

In the case of the small observatories, where teaching is expected of the astronomer, the question of economy of time is a difficult one. At Harvard and Johns Hopkins, for instance, six hours of lectures per week would be expected to occupy half of a teacher's time, while in a small establishment one cannot give that proportion and make and reduce observations. At the smaller observatories, too, there is difficulty in requiring proper preparation and in enforcing a high standard of scholarship. Men who believe that the training in law, medicine or engineering should be thorough and severe, because they think the students will be better off commercially, cannot understand that students in Astronomy ought to have the same thorough discipline.

THE EIGHTH GROUP OF THE PERIODIC SYSTEM AND SOME OF ITS PROBLEMS.

II.

We have seen that nearly half a century ago, it was clear to Claus that iron, ruthenium, and osmium belonged in a group together. It was later easily recognized that cobalt, rhodium, and iridium furnished a second triad, while nickel, palladium, and platinum must also be grouped together. The analogies between the three metals of each of these groups is too patent to require discussion, though incidentally we shall have occasion to recur to it. When the elements were arranged in the first periodic tables, these metals did not fall into orderly arrangement; as late as 1878 the atomic weight of osmium was considered greater than that of iridium, platinum, or even gold, while gold was given a weight less than that of iridium or platinum. Cobalt and nickel on one hand and iridium and platinum on the other were considered to have an identical atomic weight. The seeming impossibility of reconciling these nine metals with the periodic law is undoubtedly the reason why they were thrown

out in a single group; dumped into a chemical Gehenna as it were, while the rest of the elements were reduced to orderly arrangement. Lothar Meyer, however, saw that there was a possibility that these elements also might be amenable to system, and under his direction Carl Seubert began the revision of the atomic weight of iridium.* This he found to be more than four units less than the figure formerly used, and now the order of these elements appeared to be iridium, gold, platinum, osmium. Three years later Seubert† revised the atomic weight of platinum, finding it lower than that of gold, and this work was confirmed by Halberstadt,‡ and by Dittmar and McArthur.§ The only anomaly in these four metals now was in osmium and this also was resolved by Seubert,|| who found that the old value of Berzelius and Frémy was about eight units too high, and that so far from having an atomic weight greater than that of gold, osmium in reality has the lowest atomic weight of the four metals. This revision was justly accounted a great triumph for the periodic law.

As with the other metals, so also much doubt existed as to the atomic weights of rhodium and ruthenium, but the work of Seubert and of Joly, while changing somewhat the older figures, confirmed the order given in Meyer's table. Much work has been done on palladium by Keiser and by Keller and Smith in this country, by Bailey and Lamb and by Joly and Leidié abroad. The figures for platinum and palladium represent a much greater degree of accuracy than those for the other four platinum metals. Indeed it must be said that little accuracy can be claimed for the present figures of rhodium and iridium, and certainly those of ruthenium and osmium cannot be depended on more closely than half a unit.

In the case of the three other metals of this group, the atomic weight of iron has been well determined, but is now being subjected to a most careful examination in the laboratory of Professor Theodore Richards. As was supposed a few years ago to be the case with iridium and platinum, so cobalt and nickel were thought to have the same atomic weight. Then Lothar Meyer showed that, judged by their properties, nickel should follow cobalt in the periodic system and hence have the higher atomic weight. Revisions of these metals followed, but the more accurate the work the more probable it appeared that the atomic weight of nickel is below that of cobalt. It was suggested that nickel was quite probably a mixture and efforts were made to resolve it into its constituents. In this connection will be recalled the efforts of Gerhardt Kruss to decompose nickel, in which for some time he thought he had been successful and christened the new metal gnomium. But like so many other aspirants for chemists' favor, gnomium proved to be but a mixture. The latest work on these metals by Richards and Cushman and Baxter, far surpassing all that has previously been done, confirms the higher atomic weight of cobalt, and lends no support to the view that nickel is anything but a simple element.

Here we meet apparently one of those chemical mysteries, which seem to baffle our attempts at solution. We are not permitted to doubt the correctness of the general principles of the periodic system, and yet here, and the case is perhaps not unique, two elements seem to have exchanged places. When we know *why* the properties of an element are a function of its atomic weight, we shall perhaps come to understand why the atomic weight of nickel is not greater than that of cobalt.

* Inaug. Diss., Tübingen, 1879.
† *Ber. d. Chem. Ges.*, 14, 865 (1881).
‡ *Ibid.*, 17 (1884), 2962.
§ *J. Soc. Chem. Ind.*, 6, 799 (1887).
|| *Ber. de Chem. Ges.*, 21, 1839 (1888).

If the chemical study of these metals supports the conception of their elementary nature, an examination of the spectrum of nickel and of cobalt, and particularly of iron, forces upon us the thought of the complexity of the atom. If each line of the spectrum, representing the vibration of a certain wave length, is occasioned by a corresponding vibration of the atom, it becomes difficult for us to conceive of so many hundred simultaneous vibrations of a simple atom, a great share of which stand in no apparent harmonic relation to each other. It has been suggested that it is by a study of the spectroscopic portrayal of atomic vibration we may hope to gain the most complete knowledge of the dynamical character of the atom, but it must be remembered that with the spectroscope we study the motion of the atom at a high temperature, when vibration apparently overcomes in most instances chemical affinity; a knowledge of the atom at this temperature may give us no hint whatever as to the nature of the atom at lower temperatures, even as the spectrum of the same element may change with varying temperature. While we might thus conjecture that perhaps by some process of careful and refined fractionation, it might be possible to resolve iron into a series of meta-elements with nearly the same atomic weight, we are met by the fact that complex though it is, we find not only the same spectrum for iron whatever its terrestrial source, but that the spectrum of sidereal iron, from meteorite, from sun, from star, gives us no evidence of any variation in the composition of iron. We are, I think justified in concluding that the nine metals of the eighth group fulfill every definition of an element, and that they are just as much to be looked upon as simple elementary substances as any of those substances which we call elements; and further that while refined determinations may change, to a slight extent, the atomic weight of some of these elements, especially those of ruthenium and osmium, we may expect the weight of these elements relative to each other, and hence their position in the periodic system to remain unchanged. This, of course, carries with it the conclusion that in the periodic table an element may have an atomic weight slightly lower than that of the element which precedes it. I have discussed this possibility briefly elsewhere,* and will only add that seeming exceptions to accepted laws, instead of overthrowing the law, often serve to broaden our conception of the law itself.

Before considering some of the compounds of the metals of the eighth group, attention must be called to the phenomenon exhibited by several of these metals, and particularly by palladium, of condensing hydrogen and other gases upon their surface. The first observation in this connection seems to have been that of Sir Humphrey Davy†, who in 1817 showed the Royal Society how a warm platinum wire, plunged into the vapor of alcohol or ether or certain other inflammable gases, became incandescent, and continued to glow as long as kept in the vapor, causing an oxidation of the gas and in some mixtures even an explosion. This phenomenon attracted great attention on the part of chemists and many were the discussions over this lamp 'without a flame' or Davy's 'aphlogistic lamp' as it was called. It was soon after noticed by Edmund Davy ‡ that the platinum reduced from solution, now called platinum black, but then platinum suboxid, is especially active and can oxidize alcohol to acetic acid. In 1823 Döbereiner announced§ that platinum black and platinum sponge, when held in a stream of hydrogen, ignite the gas and that the hydrogen is absorbed

* *Chem. News*, 80, 74 (1899).
† *Phil. Trans.*, 107, 77 (1817).
‡ *Ibid.*, 110, 108 (1820).
§ *J. für. Chem.* (Schweigger), 38, 321 (1823).

by the platinum. This was the origin of Döbereiner's hydrogen lamp, regarding which he writes under date of August 5, 1823: "You have doubtless guessed before this that I have already utilized this new observation (of the heating effect of the condensation of hydrogen) for the preparation of a new Feuerzeug and a new lamp, and that I shall put it to many other important uses."* The interest which attached to this discovery of Döbereiner's can be judged from the fact that in the literature of the decade following are found over fifty references to the subject. Little attention was, however, paid to the similar action of palladium upon combustible gases, although the phenomenon had been noticed, until in 1868, half a century subsequent to Davy's first observation on platinum, Graham presented to the Royal Society his remarkable paper on the occlusion of hydrogen by metals,† followed the next year by his papers on the relation of hydrogen to palladium,‡ and additional observations on hydrogenium.§

Graham's view that the hydrogen is present in solid form as a metal and that the palladium saturated with hydrogen must be looked upon as an alloy, was received with considerable dissent. The work of Troost and Hautefeuille|| tended to the view that the substance is a definite compound, Pd_2H. Against this is the fact that the conductivity of palladium is but slightly reduced by the occlusion of hydrogen. Calculations of the specific gravity of Graham's hydrogenium by Dewar gave the number 0.62 and the same figure is obtained for the hydrogen in hydrids of sodium and potassium, studied by Troost and Hautefeuille. The recent determinations of the specific gravity of liquid hydrogen by Dewar, however, show a figure only about one-ninth of the density of occluded hydrogen, so that the question as to the nature of the hydrogen condensed by the palladium and platinum remains still unsettled. The other metals of the group possess this property to some considerable degree, but much less than is the case with palladium and platinum. In this connection it is interesting to note that one of the earliest papers of Dewar was on the motion of a palladium plate, during the formation of Graham's hydrogenium.*

Reference has been made to the natural grouping of the elements of the eighth group into three triplets, iron, ruthenium, osmium; cobalt, rhodium, iridium; and nickel, palladium, platinum. That this is a natural grouping is attested by a comparison of the compounds of these metals. However, in considering now some of these compounds the evidence of this grouping is only incidentally presented; I desire chiefly to call attention to some of the more unusual of these compounds, especially with reference to problems which this group presents, and to problems of other groups, suggested by the chemistry of this group.

The position of an element in the periodic system is, to a very considerable extent, determined by its oxids, and that too by its highest oxids, excluding the peroxids of the hydrogen peroxid type; a considerable number of these last have been studied especially by Melikoff and Pissarjewsky of Odessa, but their character still presents many points of obscurity and cannot be used with reference to the periodic law. The triplet iron, ruthenium, osmium presents the highest oxids of the eighth group, and, as is the case with other divisions of this group, an increasing stability of the higher oxids with increasing molecular weight. The type of salts of the acid-forming oxids FeO_3, RuO_3, OsO_3, occurs in this group, as in the posi-

* Loc. cit.

† *Proc. Roy. Soc.*, 16, 422 (1868).

‡ *Ibid.*, 17, 212 (1869).

§ *Ibid.*, 17, 300 (1869).

|| *Compt. rend.*, 78, 686, 968 (1874) 80, 788 (1875).

* *Proc. Roy. Soc. Edinb.* 6, 504 (1869).

tive series of the elements of the sixth and seventh groups; viz, CrO_3 MbO_3, WO_3, UO_3, MnO_3. This type is not represented in the second or third triplet of group eight. Potassium ferrate, K_2FeO_4, exists only in solution and is very unstable; potassium ruthenate, K_2RuO_4 is stable when dry but slowly decomposes when in solution; potassium osmate, K_2OsO_4, on the other hand, has a very considerable degree of stability. Of the lower base-forming oxids, iron has not only the sesquioxid, Fe_2O_3, and monoxid, FeO, but also several intermediate oxids which may be looked upon as merely compounds of these two—such is magnetite. In the case of ruthenium, the sesquioxid, Ru_2O_3, seems to be what one might call the normal base-forming oxid. The different conditions which occasion the formation of the lower oxids of osmium are ill known, though several different oxids seem to exist, as OsO, Os_2O_3, and OsO_2. Much more interest, however, attaches to the tetroxids of ruthenium and of osmium, RuO_4 and OsO_4, which are the highest volatile oxids of any known element. The almost intolerable odor of osmium tetroxid incited Tennant, in 1803, to give its name to this element, while ruthenium tetroxid, first noticed by Claus, has, if not too concentrated, a rather fresh pleasant odor, with just a suspicion of the smell of ozone, due probably to the formation of ozone in the decomposition of the oxid. As far as physical properties go, these oxids, while solid at ordinary temperature, melt easily and can be distilled. Ruthenium tetroxid is, however, far less stable than the corresponding osmium oxid, for it decomposes slowly at ordinary temperature, and explodes with great violence if heated much above 105°. On one occasion Deville and Debray* attempted to distil a hundred and fifty grams of ruthenium tetroxid, and when the temperature reached a little above 100°, the whole mass exploded with terrific violence, filling the laboratory with a dense sooty smoke. In a recent similar explosion in my own laboratory, occasioned by the contact of a little alcohol with ruthenium tetroxid, but happily on a much smaller scale than that of Deville and Debray, this black soot was found to be readily soluble in hydrochloric acid. This is unexpected, as all the anhydrous lower oxids of ruthenium are insoluble in acids, and from its methods of formation the black substance could hardly be anything other than an anhydrous oxid or the metal itself. Osmium tetroxid is commonly known as osmic acid, but as a fact these tetroxids are neither acid-forming oxids nor are they peroxids in the ordinary acceptance of the term. When treated with an alkali, we have a gradual reduction with formation of perruthenate and ruthenate, or of osmate.

Turning to the third triplet, we have the monoxid of nickel well characterized, and it is, we may say, the only well-characterized oxid of the metal, for though higher hydrated oxids of nickel exist, and perhaps anhydrous oxids also, their composition is not definitely known. With palladium and platinum also, monoxids seem to exist and dioxids as well (PdO_2 and PtO_2). Platinum dioxid may be looked upon as being perhaps a very weak acid-forming acid. While nickel forms practically only the monoxid NiO, and iron forms from choice, as we might say, the sesquioxid, Fe_2O_3, the intermediate metal cobalt, while forming most generally the monoxid, is easily oxidized to the sesquioxid, Co_2O_3, and thus cobalt may be considered in its relations to oxygen, as intermediate between nickel and iron. Similarly in the case of rhodium and iridium, there is a strong tendency to form the sesquioxid, so that this middle triplet is intermediate between the other two triplets of the group. As a whole, there is a large field at hand in a revision of the

* *Ann. Chim. Phys.* [5], 4, 537 (1875).

oxids of this group, especially those of the first triplet.

The same may be said even more emphatically of the sulfids. Those of iron, cobalt and nickel are fairly well investigated, but of the remainder comparatively little is known except the somewhat exhaustive work of Schneider on the thioplatinates and thiopalladates. After a very considerable amount of work upon the sulfids of ruthenium, I have come to distrust nearly all that has been published and to have nothing definite to add myself. The precipitates with hydrogen sulfid from ruthenium solutions ($RuCl_3$) contain apparently a considerable amount of free sulfur, but oxidize very rapidly with formation of sulfuric acid on drying, making their composition very difficult of determination. From ruthenate solutions a sulfid is precipitated which seems to have the formula RuS_3, but there is no assurance that a part of the sulfur may not be free and not combined.

Of all the compounds of the metals of the eighth group, by far the best investigated are those with the halogens, and upon our knowledge of these rests the greater part of our chemical knowledge of the platinum metals. Yet here again our knowledge is wholly inadequate. If we except the work done under Wöhler's direction by Oppler and Birnbaum on the bromids and iodids of iridium, that by Topsöe on the bromids and iodids of platinum, we may say that very little is known of any halids of this group except the chlorids. In some instances, as with ruthenium, even the chlorids are very unsatisfactorily known. Of nickel we know only the bichlorid $NiCl_2$; of cobalt the only stable chlorid is the bichlorid, $CoCl_2$, but the trichlorid, $CoCl_3$ seems capable of existence in solution; of iron, the ferric chloride, $FeCl_3$, is the stable compound, into which the ferrous chloride, $FeCl_2$, is readily oxidized. Here again the intermediate position of cobalt is apparent. There is a strong tendency on the part of all these chlorids to form double salts, of which we have examples in K_2FeCl_4, $3H_2O$, K_2FeCl_5, and Rb_3FeCl_6. These salts seem to be broken up in solution and the chlorin can be precipitated by silver nitrate. Turning to the halogen compounds of the platinum metals, we find double salts of a very different character. The common types for platinum and palladium, for example, are K_2PtCl_4 and K_2PtCl_6. This latter type seems also to be known for all platinum metals except rhodium. Osmium, iridium, and rhodium present also the type K_3OsCl_6, while ruthenium and rhodium also form salts of the type K_2RuCl_5. The most important features of these salts is that they are not decomposed when dissolved in water, silver nitrate precipitating not silver chlorid alone, but the double chlorid of the metal and silver; that is, for example, when K_2PtCl_6, is dissolved in water, it is electrolytically dissociated, K being the positive ion, while the negative ion is the group $PtCl_6$. The platinum metal then in these salts is a part of the negative ion. Double salts of this class are, of course, well known, but nowhere are they developed to the same extent as in the eighth group, indeed double salts of several acids are found among no other metals. The question may be fairly raised among the platinum metals as to whether there is any salt which is electrolytically dissociated giving the platinum metal as the positive ion.

The chlorids of ruthenium furnish an instructive illustration of the difficulties which may arise in getting complete knowledge of chemical facts as to what would naturally be considered simple substances. As we have seen, Claus discovered ruthenium in 1844. He obtained two chlorids or rather double chlorids, the one K_2RuCl_5 and the

other K_2RuCl^6, the former corresponding to the type found in osmium and rhodium, the latter to that found in platinum and palladium as well as in iridium and osmium. In describing this latter salt, Claus shows that it was in the hands of Berzelius and probably in a pretty pure state, but that great chemist thought it to be an iridium salt, Berzelius was not convinced, and in the 'Handwörterbuch der reinen und angewandten Chemie,' edited by Liebig, Poggendorff and Wöhler, the work of both Berzelius and Claus is given. This was naturally somewhat irritating to Claus and he writes:* "Even if reverence for the great authority of the great chemist (Berzelius) should seem to justify such a course, regard for the truth of science should not have permitted it." The subject was now dropped and for a third of a century no one had worked upon this chlorid, when Professor A. Joly, of the l'École Normale, began his study of the platinum metals, and much of the work of Claus upon ruthenium was revised. Now it appears that not only Berzelius, but also Claus himself was mistaken, and what he had taken for a chlorruthenate, K_2RuCl_6, was in a reality a *nitroso chlorruthenate*, K_2RuCl_5NO. My own work of a little later date upon the chlorids of ruthenium abundantly confirmed this. Many efforts were made to prepare a tetrachlorid of ruthenium but it proved elusive. It may be noted in this connection that the cesium and rubidium nitrosochlorids exist in an anhydrous as well as in a hydrated form and while the very easily soluble hydrated salts lose their water on warming the solution, the very slightly soluble anhydrous salt being precipitated, the reverse change is seemingly impossible, as the anhydrous salt will not take up water and pass back into the hydrated form.

The history of the higher chlorid of ruthenium is not yet completed. Within the past year Professor Ubaldo Antony and A. Lucchesi, of the University of Pisa, have described* the preparation of the real tetrachlorid, K_2RuCl_6, which like the corresponding salts of platinum and the other metals of the group, crystallizes in octahedra. I have more recently by methods similar to those of Antony, prepared the cesium salt, Cs_2RuCl_6, which also crystallizes in octahedra and corresponds to Antony's salt; and I have also been fortunate enough to obtain a new salt of a rare type, lying intermediate between the tetroxide and the tetrachlorid, $Cs_2RuO_2Cl_4$ ($2CsCl, RuO_2Cl_2$). Now a question may arise here as to whether Claus was after all, wrong in believing he had the tetrachlorid. As the salt was commonly made by Claus, by the action of nitric acid, it was, without question, a nitrosochlorid, and his description corresponds completely; but Claus adds in a footnote† that it is also possible to prepare the salt by heating the trichlorid with potassium chlorate and hydrochloric acid. This could not give the nitrosochlorid, but while under these conditions the tetroxid is usually formed, it is possible that the tetrachlorid may also have been formed. In another place he speaks of making it by action of hydrochloric acid on potassium ruthenate, but in the presence of saltpeter. Except for this latter salt, this is the method of Antony, but usually at least it gives the trichloride. The salt which Claus generally describes is the nitrosochlorid, but in one place‡ he says the salt seems to be dimorphous, for after crystallizing out the common prismatic crystals (of the nitrosochlorid) he, on one occasion, obtained large regular octahedra, isomorphous with tetrachlorids of the other platinum metals. As the molecular weight of the nitrosochlorid is almost the same as that of the

* *Bull. Akad. St. Petersb.* (2), 108, 1 (1860).

* *Gazz. chim. ital.*, 29 i (1899).

† *J. prakt. Chem.*, 39, 96 (1846).

† *Bull. Akad. St. Petersb.* (2), 1, 105 (1860).

tetrachlorid, and as the chlorin seems to have been generally estimated by loss, analysis would reveal no discrepancy, but in one case at least, the chlorin was directly determined, and these figures can be accounted for only on the supposition that in this case it was a tetrachlorid which was analyzed; so that it would seem possible that Claus actually formed the tetrachlorid, although he did not distinguish it from the nitrosochlorid. Even now the conditions of formation of the tetrachlorid are obscure, and not less so is the cause of a phenomenon, noticed first by Claus, and since his day used as a test for the detection of ruthenium, and which is familiar to all of you who have experimented at all with this metal. I refer to the beautiful indigo-blue color assumed by the solutions of ruthenium trichlorid when hydrogen sulfid is led into them. Since, at the same time, sulphur is precipitated, and since the trichlorid also assumes a blue color on treatment with metallic zinc,* it was assumed by Claus that reduction takes place and hence that the solution contains ruthenium bichlorid, $RuCl_2$. When ruthenium is heated in a current of mixed chlorin and carbon monoxid, it increases many times in volume and there is formed an anhydrous trichlorid. This is insoluble in water and in strong alcohol, but dissolves with considerable readiness in dilute alcohol to a similar deep blue solution. Joly succeeded in distilling off the alcohol and water from this solution, in a vacuum, and obtained a blue deliquescent substance which he considered to be an oxychlorid, $RuOHCl_3$. I have also formed this blue solution by electrolytic action, and while it seems to be formed by a reducing action, this is not perfectly clear. Considerable work upon this solution, however, leads me to agree with Claus that it is probably a lower chlorid of ruthenium, but it has not been proved. I have dwelt perhaps unduly upon these compounds for the purpose of showing the obscurity in which even such seemingly simple points are enveloped, for it well illustrates how much work must yet be done before we acquire any adequate knowledge of the nature of even the commoner compounds and reactions of these elements.

Of the simple salts of oxy-acids few are known of any metals of this group except the lower series, iron, cobalt and nickel; a single sulfate of rhodium, one of palladium, and perhaps a double sulfate of platinum, a chromate of iridium, a basic carbonate of palladium, two or three nitrates, a phosphate of rhodium, and a hypophosphite of platinum; such is practically the whole list. The platinum metals have little tendency to form crystalline salts with oxy-acids, and many such salts are unquestionably incapable of existence, but in many cases at least the difficulty is our ignorance of the condition of formation of such salts. And herein, I may say, is one of the most marked differences between investigation in organic and in inorganic chemistry. In the former the field has been so thoroughly studied that the conditions of reaction are often well known and the course of a reaction can be foretold with considerable certainty; in inorganic chemistry the work is like exploration in an almost wholly unknown land. We know neither the possibility of existence of conjectured compounds, nor the conditions under which alone such formation or existence is possible. For this reason inorganic research is slower and far more apt to be fruitless. No better example of this can be cited than the fact already referred to that Professor Joly, as well as myself, exhausted every method which occurred to us for the formation of the tetrachlorid of ruthenium, and failed in our efforts by missing just the proper con-

* It has already been mentioned that Vauquelin had noticed this blue color, but not knowing of ruthenium had attributed it to osmium.

ditions, which happily Professor Antony has hit upon.

But while the platinum metals seem to form few simple salts, few or none show such a decided tendency to form double and complex salts, and this property is, to some extent, shared by the three light metals of the group.

Best known and best developed of these compounds are the cyanids, which are especially familiar to us in the prussiates of iron. In nickel we have the ordinary cyanid, $K_2Ni(CN)_4$ or $2KCN, Ni(CN)_2$, formed by the solution of nickel cyanid in potassium cyanid. As electrolytically dissociated, the nickel is a positive ion, and the double salt is at once broken up by acids with the precipitation of nickel cyanid. The double cyanid of palladium, $K_2Pd(CN)_4$ is similar but less easily decomposed. The corresponding double cyanid of platinum, $K_2Pt(CN)_4$ is clearly a salt of the complex platinocyanic (or cyanoplatinous) acid, $H_2Pt(CN)_4$, which is formed on treating the salt with a strong acid, can be separated in a pure condition, and is an acid strong enough to expel hydrochloric acid from sal ammoniac. The platinum atom is here a constituent of the negative ion, $Pt(CN)_4$.

If we proceed from nickel along the horizontal series, we find that while a double cobalt cyanid, $K_4Co(CN)_6$ or $4\ KCN,Co(CN)_2$, can be formed, it is very unstable, and belongs to the same easily decomposable class as the double nickel cyanids. This cobalt cyanid has, however, a great tendency to oxidize and form potassium cobalticyanid, $K_3Co(CN)_6$, which is stable and a salt of the cobalticyanic acid, which can be obtained in a free state. In passing we note a very interesting point, that under the influence of such reducing agents as potassium cyanid, potassium nitrite, and potassium sulphite, cobalt shows a great tendency to become oxidized from its bivalent condition to the very stable complex compounds in which it is trivalent; under other circumstances, simple compounds in which cobalt is trivalent are formed with great difficulty and are of decided instability. This seeming anomalous property still demands an explanation.

Turning to the iron cyanids we find both types, $K_4Fe(CN)_6$ and $K_3Fe(CN)_6$, ferrocyanid and ferricyanid, well developed and extremely stable. From each, the corresponding acid can be obtained in a free state, and is a strong acid. Of the remaining metals, the double cyanids of rhodium and iridium resemble the cobalticyanid, while of iridium the iridocyanid, $K_4Ir(CN)_6$ is also known, and is stable, thus completing the analogy found in the nickel group. Potassium ruthenocyanid, $K_4Ru(CN)_6$ and osmocyanid, $K_4Os(CN)_6$ resemble the ferrocyanid, the free acids being easily separable from the salts. Outside of the eighth group, the stable complex cyanids are known only in the case of manganese and chromium.

Regarding the constitution of the double cyanids, you are all familiar with the various suggestions that have been made from time to time, which involve the polymerization, probably by threes, of the cyanogen group. To this there have been raised two objections: an explanation which is satisfactory for the double cyanids should also be available for the double chlorids, as K_2PtCl_6 which are also salts of complex acids, and where polymerization by threes is at least improbable; and second it is possible to replace a single cyanogen group or chlorin atom, without changing essentially the nature of the molecule, as in sodium nitroprussid, $Na_2Fe(CN)_5NO$, and potassium nitrosochlorruthenate, K_2RuCl_5NO. There is a large field for study in these cyanids from the standpoint of the newer physical chemistry.

Closely connected with the chemistry of the cyanids is that of the thiocyanates, but

it has been very meagerly worked out for the eighth group. In the case of platinum both potassium plato- and platithiocyanates, $K_2Pt(SCN)_4$ and $K_2Pt(SCN)_6$, are known, and are salts of the plato- and platithiocyanic acids. These are complex acids and may be separated out, but in the free state are very unstable. The double ferric thiocyanates may be formed but there is no corresponding complex acid, that is, they are ordinary double salts. The ferrous, cobaltous, and nickel thiocyanates are known, but form no double salts. It is extremely probable that the other metals of this group would show a full series of thiocyanates.

Another interesting class of complex salts is that of the double nitrites, first studied in the case of platinum by Nilson, but for the other platinum metals by Wolcott Gibbs, who bases upon these his method of separating the metals. More recently these nitrites have been investigated by Joly, Vèzes, and Leidié. The most familiar double nitrite is the potassium cobaltinitrite, which has long served for the separation of cobalt from nickel, and which is also used as a pigment under the name of aureolin or cobalt-yellow. These nitrites resemble, to a considerable degree, the double cyanids, and in the case of iridium the free complex iridonitrous acid has been obtained. In the case of iron, cobalt, and nickel, we have also representatives of a large class of very staple triple nitrites, first noted by Künzel and Lang and studied by Erdmann.* More recently these have been investigated by Przibilla† who, after great difficulty, succeeded in preparing the triple iron potassium nitrites with lead, barium, strontium, and calcium; this is the first nitrite of iron to be prepared and leaves osmium as the only metal of the eighth group of which no nitrite is known.

In the case of all platinum metals double sulfites are known, which are salts of complex metallo-sulfurous acid. In these metals the presence of the sulfurous acid radical cannot be detected by ordinary reagents. In the case of cobalt, a full series of cobaltisulfites is known, which are stable salts, while the cobaltosulfites are very unstable. Little is known of iron and nickel sulfites, and there is much room for further investigation in the case of the sulfites of the other elements of this group. There is at the same time reason to believe that a study of the thiosulfates and possibly the dithionates of this group would not be without interest.

Another acid which is capable of forming complex salts is oxalic. The platoxalates are the only ones which have been carefully studied, though some work has been done upon the rhodoxalates. Several iron oxalates and double oxalates are known, but aside from this the field is unworked but promising. In this connection it may be added that while oxalic acid is the only organic acid which has been investigated to any considerable extent in complex salts, it by no means follows that it is the only acid which is capable of entering into such combinations. Some of my students have made preliminary tests with a large series of acids and found that several among them enter combination with chromium with the formation of complex salts, and it is quite possible that similar compounds may be formed with the eighth-group metals. Mention should also be made that Gibbs has introduced platinum into his complex salts, forming platinimolybdates and platinitungstates.

Since complex salts of hydrocyanic, nitrous, sulfurous, oxalic, and other analogous acids are best developed generally with the metals of this group, it is in the study

* *J. prakt. Chem.* 97, 385 (1866).

† *Ztschr. anorg. Chem.*, 15, 419 (1897).

of these and other compounds of this group that we may hope to gain an insight into the constitution of these interesting compounds of which so little is known, and further extend our knowledge regarding valence, for it is just at this point that the generally accepted theory of valence begins to break down.

Before alluding to the ammonia bases, which are so well developed in this group, and would naturally follow these complex salts we have just considered, a brief digression may be made to refer to three classes of anomalous compounds, which should not be passed without reference. The first of these is the nitroso compounds. It is only recently that, largely through the efforts of Joly, the nature of the so-called nitro-prussids was discovered,—double cyanids in which one cyanogen group is replaced by one nitroso group, NO. Joly then found that the old osmiamic acid of Fritzsche and Struve is also to be considered as a nitroso compound, and that the supposed tetrachlorid of ruthenium is, in reality, a nitroso-chlorid. But while there appear to be no representatives of the nitroso compounds in the cobalt or the nickel groups, several other compounds of iron are known which contain this group, as the potassium iron tetra- and heptanitroso-sulfonates, $K_2Fe_2(NO)_4S_2$ and $KFe_4(NO)_7S_3$, and the iron nitroso-thiocarbonate and thio-antimonate of Löw. There seems also to be a nitroso-cyanid of ruthenium, corresponding to the nitroprussids, but it has not been isolated. In none of these cases has the interesting question been brought out as to whether the nitroso group remains attached to the metal when in solution, or whether it is electrolytically dissociated and acts the part of an acid radical.

In some respects yet more remarkable are the compounds formed with carbon monoxid and with phosphorus trichlorid. The best known compound of this class is the nickel carbonyl, $Ni(CO)_4$ of Ludwig Mond. The nature of this volatile liquid is yet unknown, but it is by no means unique. Immediately after its discovery it was found that iron formed similar compounds, $Fe(CO)_5$ and $Fe_2(CO)_7$. That a volatile compound of iron exists had been very apparent on the lime of the Drummond light, when water gas, compressed in iron cylinders, was used instead of hydrogen, and also in the clogging of gas burner tips with an oxid of iron, especially when a carburetted water gas is used as an illuminant. The volatile iron carbonyl seems to be formed at ordinary temperatures by the passage of carbon monoxid through iron pipes. But it is not alone with metals that carbon monoxid combines to form volatile compounds. As early as 1868 Schützenberger* discovered that platinous chlorid $PtCl_2$ would combine directly with carbon monoxid, with the formation of three distinct compounds, containing respectively one, two and three molecules of CO to one of $PtCl_2$. A compound is also known in which one CO group replaces one cyanogen group in potassium ferricyanid, that is $K_3Fe(CN)_5CO$. This reminds us naturally of the nitroso-ferrocyanid, the so-called nitroprussid. Again in 1870 Cahours and Gal† discovered a series of compounds containing platinous chlorid united with phosphorus trichlorid, and also with some of the organic phosphins. These compounds are not of the nature of double chlorids, for they can be hydrolyzed with the formation of chlorplatophosphorous acid. An analogous class of compounds of iridium has been made by Geisenheimer,‡ which are also capable of hydrolysis, giving chloriridophosphorous acid. Geisenheimer has formed similar compounds con-

* *Compt. rend.*, 66, 666, 747 (1868).
† *Comp. rend.*, 70, 897, 1380 (1870); 71, 208 (1870).
‡ *Comp. rend.*, 110, 1004 (1890).

taining bromin* in the place of chlorin, and also others containing arsenic† in the place of phosphorus. How far compounds of this nature can be extended is only conjectural, but there is evidence of the existence of something of the kind with iron.

Of binary compounds with the less negative elements, such as the phosphids and carbids of iron, little is known. Like iron, nickel and also platinum and iridium form phosphids. Iridium phosphid possesses an economic importance in that it enables the metal to be fused in a furnace. Up to the discovery of this process in 1882 by Dr. Wm. L. Dudley, the native grains of iridosmium were alone available for tipping gold pens, stylographs, and the like. It was, however, found that when iridium was heated to a high temperature in a crucible, on introducing a piece of white phosphorus, the whole mass immediately melted, and could be cast into plates, afterward to be worked up into desired form. This reminds one of the early method of working platinum by alloying it with arsenic and then roasting the arsenic off in a muffle.

There remains a single class of compounds to be noticed, the ammonia bases, whose greatest development is found in this group. The first member of this class was the compound now known from its discoverer as the green salt of Magnus, which was first made in 1828.‡ Then came the work of Gros, of Reiset, and of Peyrone. Among the many chemists who have cultivated this field are Cleve, Jörgensen, who has given us most of our knowledge of the rhodium bases; Gibbs, Palmaer, who has developed the iridium bases, and Joly, who has revised the bases of ruthenium; while the theory of these bases has been discussed especially by Claus, Blomstrand, Jörgensen, and Werner. In connection with these bases appear what must, with our present knowledge, be considered anomalies. The greatest development of these bases is found with platinum, where nearly or quite a dozen distinct classes of bases are known, and where we find several groups of isomers, which Werner seeks to explain as stereo-isomers, while Jörgensen strenuously combats the view. In type, the palladium bases resemble those of platinum, but as far as yet studied are much less well developed. Nickel, on the other hand, forms no true bases, though many ammonia compounds. The cobalt, rhodium, and iridium bases are all formed on the same general types, but by far the greatest development is found in cobalt, which almost rivals platinum in the number of classes; but few of these are developed with iridium, and fewer still with rhodium. In the iron group no bases are formed by iron, and only two or three ammonia compounds; ruthenium and osmium form fewer bases as far as yet investigated, than any of the other platinum metals. It it interesting to note, however, that one of these ruthenium bases, discovered by Joly, and which possesses intense tinctorial power, resembles very strongly an organic dye, both on fabrics and as a stain in microscopy. The constitution of the ammonia bases is to-day, as it has been for half a century, one of the greatest problems of inorganic chemistry, and it is apparently no nearer solution. In accordance with the valence theory, it becomes necessary with Jörgensen to assume the existence of chains of at least four NH_3 groups in a molecule, stable enough to be unaffected by aqua regia and also that these ammonia groups are replaceable by water molecules. We must also assume that while in ordinary salts, as for example chlorids, the chlorin atoms, which are directly united with the metal, are dissociated in aqueous solution, in these bases the chlorin which is directly united with the metal is not dissociated, but

* *Ibid.*, 111, 40 (1890).
† *Ibid.*, 110, 1336 (1890).
‡ *Ann. der Phys.* (Pogg.), 14, 239 (1828).

that which is united with the metal through the medium of one to four ammonia groups is dissociated. Led by a consideration of these seeming inconsistencies, Werner has proposed his theory of co-ordinated groups within the molecules; a theory which seems to possess at least elements of truth, even if not expressing the whole truth. It is possible, too, that Werner's theory may explain some of the difficulties of the theory of electrolytic dissociation, and harmonize it with the hydrate theory of solution.

The constitution is, however, not the only problem of these bases. To my mind their connection or rather lack of connection with the periodic system is one of the most inexplicable facts in chemistry. It makes it apparent that while the periodic law expresses a truth without doubt the greatest generalization of modern chemistry, yet even this is in its present statement not the whole truth. We find a marvelously full development of these bases in connection with cobalt, platinum, and chromium. Manganese and iron which lie between chromium and cobalt form no bases. The higher members of the chromium group, that is, molybdenum, tungsten, and uranium, form no bases, while the higher members of the iron series, that is, ruthenium and osmium do. Of nickel, which stands next to cobalt and resembles it so closely, no bases are known, and yet it is the lowest member of the series which contains platinum. It is true that bivalent cobalt forms perhaps like nickel, no bases, but as trivalent cobalt forms so many bases, trivalent iron would seem likely to form many, instead of none. If indeed manganese and iron are capable of forming these bases, it seems strange that no one has yet happened upon the proper conditions. It is the consideration of a subject like that of these inorganic bases, which forces upon us a realization of how much there is after all which we do not know about chemistry.

We turn now to a short consideration of the eighth group from a theoretical stand-

Periodic Table By F. P. Venable—Modified.

H																						He	
Li		Gl		B		C		N		O		F										Ne	
Na		Mg		Al		Si		P		S		Cl										Ar	
K	Cu	Ca	Zn	Sc	Ga	Ti	Ge	V	As	Cr	Se	Mn	Br	Fe	?	Co	?	Ni					
														[8 2]		[8 4]							
Rb	Ag	Sr	Cd	Y	In	Zr	Sn	Cb	Sb	Mo	Te	—	I	Ru	?	Rh	?	Pd					
Cs	?	Ba	†	La	†	Ce	†	*	†	*	†	*	†	*		*		*					
*	Au	*	Hg	*	Tl	*	Pb	Ta	Bi	W	†	*	†	Os		Ir		Pt					
* + Series	— Series	* +	—	* +	—	Th +	—	* +	—	U +	—	+	—										

* Possible + Series elements. † Possible — series elements. — Eka-manganese.

point. Following Dr. Venable* we may assume that each of the first seven groups consists of a group element, as in group one, lithium, a type element as sodium, and two series, one of more positive elements as potassium, rubidium and cesium, and the other more negative, as copper, silver and gold. Further, the more positive the type metal, the more closely will the metals of the positive series resemble it; the more negative the type metal, the more closely will the negative series resemble it. Thus in the first group, the positive series potassium, rubidium and cesium closely resembles the type element sodium; in the seventh group the negative series, bromium and iodin, resembles the type element chlorin. Now the eighth group differs materially from the other seven in that it contains three series, with no group or type element. These three series are transitional from the least positive among the seven positive series, manganese, to the least negative among the negative series, copper, silver and gold. The properties of the metals of group eight show this transition as from a chemical standpoint, iron, cobalt and nickel form a direct gradation between manganese and copper. Now comes a further question as to possible transition elements between the most negative series, fluorin, chlorin, bromin, iodin, and the most positive series sodium, potassium, rubidium and cesium. From a theoretical standpoint such transition elements should be neither positive nor negative, and should have a valence of zero. A few years ago the realization of such a conclusion would have seemed impossible, yet since the discovery of argon and its congeners, it seems almost probable that these places have been filled in accordance with theory. If we take the most generally accepted atomic weights, we find helium preceding lithium, neon following fluorin and preceding sodium, and argon, really between chlorin and potassium, but with an atomic weight apparently slightly greater than that of potassium which follows it, resembling in this respect cobalt and nickel of this same group, and also tellurium and iodin. There would, in addition, be expected from the analogies of group eight, one, two, or three transitional elements between bromin and rubidium, of atomic weight, 80 to 85, and Ramsay has suggested that krypton may belong in this place—so also an element or elements of similar character might be expected between iodin and cesium, with atomic weight of about 130. The recently published work of Ladenburg and Kruegel on krypton give it an atomic weight of about 59. This would, as Professor Ladenburg suggests, make it immediately precede copper, but unless we change very materially our ideas of the periodic law, it is difficult to conceive of an element with the properties of krypton lying between nickel and copper. If these inert gases belong in the eighth group it may seem strange that iron and the other familiar metals which belong here should be so unlike such a type element as argon or neon; it must, however, be borne in mind that this is only an expected exaggeration of the departures found in the first and seventh groups, where copper departs from its type element sodium, and manganese from its type element chlorin. As to whether three elements are to be expected of atomic weight 150 between the light and the heavy platinum metals we have little data upon which to theorize. As a matter of fact, there is very little definite knowledge of the elements between cerium and tantalum. The inter-Jovian planet proved to be an indefinitely large number of asteroids; Sir William Crookes' study of the rare earths leads him to the conception of a group of asteroidal meta-elements in this vacant space in the periodic table. We must await further knowledge be-

*See periodic table.

fore these problems can be satisfactorily solved.

In conclusion one word as to a very practical problem connected with this group. It is but a few years past a century since the use of platinum was introduced into the chemical laboratory. For a few decades the supply exceeded the demand, but the applications of platinum have steadily increased, and never so rapidly as in the last two decades. For many purposes no substitute for platinum has been found. At the same time the supply of platinum is not keeping pace with the demand, and as a result the price of platinum has very materially advanced. While platinum is very widely distributed, there are few places where it occurs in workable quantities. It is possible, however, that it has been often overlooked, as in placer mining for gold, and efforts have been made to attract miners' attention to more careful search for platinum deposits. At the present outlook it will, within a few years, be imperatively necessary either to materially increase the platinum supply of the world or to replace it for many purposes by some other substance. How this problem will be solved cannot now be foreseen.

Jas. Lewis Howe.
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SCIENTIFIC BOOKS.

The Elements of Physics for Use in High Schools. By Henry Crew, Ph.D., Professor of Physics in Northwestern University. New York, The Macmillan Company. 1899. Pp. 347.

One of the most striking indications of the steadily increasing demand for instruction in science as a part of elementary education, is found in the periodic recurrence of new books on a market that would seem to have become already overcrowded. If the new competitor is written by one who manifests his possession of the teacher's instinct in addition to the scholar's knowledge, its reason for existence is quickly established. The author of the present volume plainly shows himself to be the possessor of both, though as a teacher he may have had little experience in the grade of schools for which his book is intended. In the preface he expresses his obligations to one friend, a high school teacher, 'for many important excisions in the MS.,' and his readiness to have others 'point out sins either of omission or of commission.'

In criticising such a book it is a pleasure to find so little to condemn, even if a few more excisions may seem advisable. Physics is essentially applied mathematics, even when no attempt is made to introduce openly the ideas of calculus or even of trigonometry. It is most natural therefore that a physicist, who is not himself a high school teacher, should overestimate the ability of the average high school pupil to grasp mathematical conceptions that are not usually introduced in the work of the secondary school.

In the introductory chapter on motion a brief and clear exposition of vectors and scalars is given, and a subsequent application is made in the discussion of uniform motion in a circle, where the position vector and velocity vector are contrasted, and the nature of the path deduced, along with the formula for acceleration in terms of radius, angular velocity, and periodic time. There is no theoretic objection to this, but it is probably safe to predict that many secondary pupils will agree in thinking the discussion much too abstract for them. Indeed it would not be hard to find college juniors of literary bent, who would be sympathetic with their friends in the preparatory school, and who would congratulate themselves on the absence of problems, necessary as these may be to bring home a difficult subject. There are fashions in educational method as well as in dress. Whether the vector analysis fashion can be maintained in elementary schools may be doubted. To immature students the method is certainly not so easily grasped as are some other methods that have hitherto been satisfactory to many.

In the discussion of angular motion much stress is laid upon the distinction between speed and velocity, the former being a scalar and the latter a vector quantity. This distinction has

been more or less familiar ever since its introduction by Thomson and Tait, but to young students it can scarcely fail to bring uncompensated trouble. Among the problems on this subject is the following: "What is the aim of the clockmaker; to produce an instrument which will give constant angular speed or constant angular velocity?" It is perhaps safe to say that few clockmakers would answer with confidence; and probably some teachers would hesitate also, especially after trying to assure themselves that "an ordinary peg top may be used to illustrate the case of a body having a constant angular speed, but at the same instant a variable angular velocity." For mental gymnastics in following out the metaphysics of a definition the distinction may have its value; but there are many whose maturity exceeds that of high school pupils, and who find the word velocity, with suitable adjuncts, quite enough for all practical purposes. The facts give little trouble, for velocity in any given direction can always be specified, while words may become tyrants.

As an exact science physics is built up on dynamics as a foundation. The study of linear, angular, and harmonic motion therefore constitutes its most natural introduction, along with the consideration of the general properties of matter, of momentum, rotational inertia, and universal gravitation. Each of these subjects is treated with intelligence and skill, with mathematics that is not abstruse for a college student, but in a style that seems rather severe for the preparatory schools. Indeed the first hundred pages of the book, relating to subjects that admit of but little experimental illustration, are certainly rather hard for students below collegiate grade. Passing on then to wave motion and acoustics, the rest of the volume is non-mathematical and very attractive.

In the discussion of sound the building of the musical scale is brief, yet clear; but it seems a little unfortunate that the frequency of middle C should be given as 264. This number was adopted by the Stuttgart Congress in 1834, and the scale built upon it was used in Helmholtz's 'Sensations of Tone'; but it never won universal adoption. Within the last few years, and largely through the activity of the late Governor L. K. Fuller, of Vermont, all the civilized nations of the world have adopted A, 435, as standard pitch for the construction of musical instruments, England being the last to yield. As all keyed instruments are made with the aim of producing the equally tempered scale, rather than the diatonic scale, it is readily found, by application of the proper factor, $(1.05946)^{-9}$, that the frequency of the middle C, for this international pitch, is 258.65. For the purpose of the physicist the diatonic scale will probably continue in use, and Koenig's forks are universally regarded as the best. These are tuned, unless specially ordered otherwise, to the so-called physical pitch, introduced a century ago by Chladni, with $C_3 = 256$. The wild confusion of a generation ago has now been reduced to order, with the survival of but two definitely related systems. One of these is international pitch, with $A_3 = 435$ as starting point for the scale of equal temperament; the other is physical pitch, with $C_3 = 256$ as starting point for the diatonic scale. Each of these is of course arbitrary, the result of agreement, while the equally arbitrary Stuttgart pitch is now of only historic interest. In a text-book of physics it may be mentioned, but should no longer be taught; and 256 rather than 264 should be the basis for a diatonic table of frequencies.

The closing chapters on heat, magnetism, electricity, and light are well arranged, clearly expressed, and modern in style of treatment, with judicious omission of much that the high school pupil can well afford to disregard until the subject is resumed in college. For example, the polarization of light is not mentioned, while diffraction comes in as an elementary illustration of the wave theory, a few simple experiments being explained which are both interesting and easily made. In the development of the laws of geometrical optics, wave fronts are freely indicated in the diagrams, but equally free use is made of the convenient term 'ray.' The fact that this means merely a direction is no reason for abolishing it, as has been done in a few recent text-books of physics.

W. LE CONTE STEVENS.

WASHINGTON AND LEE UNIVERSITY.

BOOKS RECEIVED.

Photometric Measurements. WILBUR M. STONE. New York and London. The Macmillan Co. 1900. Pp. vii + 270. $1.60.

A Manual of Elementary Practical Physics for High Schools. JULIUS HORTVET. Minneapolis, H. W. Wilson. 1900. Pp. x + 255.

Comparative Anatomy of Animals. GILBERT C. BOWNE. London, George Bell & Sons. 1900. New York, The Macmillan Co. 1900. Pp. xvi + 269.

SCIENTIFIC JOURNALS AND ARTICLES.

The American Naturalist for June opens with an excellent account of 'The Neurone Theory in the Light of Recent Discoveries,' by G. H. Parker, originally given as a lecture before the Section of Biology, New York Academy of Sciences. 'Variation in the Venation of Trimerotropis,' is discussed by Jerome McNeil, with the rather surprising conclusion, among others, that variations in venation may be much greater within a species, than those difference which distinguish one genus from another. Robert T. Young presents some 'Notes on the Mammals of Prince Edward's Island,' and T. D. A. Cockerell notices 'The Cactus Bees, Genus *Lithurgus*' recorded from New Mexico. C. B. Davenport summarizes 'The Advance of Biology in 1897' as indicated by the contents of *L'Année biologique* for that year and F. W. Simonds has a paper, presented before the American Association last August, 'On the Interpretation of Unusual Events in Geologic Records, illustrated by Recent Examples.' Part X of the 'Synopses of North American Invertebrates' is by Mary J. Rathbun and is devoted to 'The Oxyrhynchous and Oxystomatous Crabs.'

The Popular Science Monthly for July has for its frontispiece a portrait of G. K. Gilbert. Simon Newcomb has some 'Chapters on Stars' and W. M. Haffkine gives the second and final part of his very interesting article on 'Preventive Inoculation.' James Collier presents the second of his papers on 'Colonies and the Mother Country' and G. F. Swain gives an account of 'Technical Education at the Massachusetts Institute of Technology,' which includes the history of the institution in brief and is illustrated by views of the laboratories and portraits of its various Presidents. G. T. W. Patrick discusses 'The Psychology of Crazes,' concluding that ethically and intellectually social or collective man is far behind individual man. Edward Renouf considers 'Some Phases of the Earth's Development in the Light of Recent Chemical Research,' and S. P. Langley contributes 'A Preliminary Account of the Solar Eclipse of May 28, 1900, as observed by the Smithsonian Expedition.' 'Malaria and the Malarial Parasite,' by Patrick Manson, gives a good resumé of the subject, and finally Henry Carrington Bolton briefly notices 'New Sources of Light and of Röntgen Rays.' Under Discussion and Correspondence, Charles D. Walcott tells of 'Washington as an Explorer and Surveyor,' while the thanks of the many are due to 'Physicist', who under the caption 'Science and Fiction' reviews Tesla's recent article in the *Century*.

The Osprey for May, rather belated, begins with part V of 'Birds of the Road,' by Paul Bartsch, followed by 'Notes on the Habits of the Blue Jay in Maine,' by J. Merton Swain. Theodore Gill gives the third instalment of 'William Swainson and his Times,' which contains some important information regarding his publications. M. A. Carpenter, Jr., describes 'The Chickadee (*Parus atricapillus*) in Eastern Nebraska' and some 'Remarks on Some of the Birds of the Cape of Good Hope,' by Phillip Lutley Sclater is reprinted from *the Ibis*.

SOCIETIES AND ACADEMIES.

TORREY BOTANICAL CLUB.

ON May 30, 1900, a meeting was held at Hazelwood, the residence of Vice-President Dr. T. F. Allen, near Litchfield, Conn., subsequent to a field excursion arranged by Dr. Allen in the vicinity of Litchfield, the Club being his guests from May 29th to 31st.

Professor Lloyd called attention to the occurrence of nectaries* on the leaves of *Pteris aquilina*. The glands are found on the rachis, one below the insertion of each pinna, and may be recognized as modified oval areas covered by a dark red epidermis. The color is due to the presence of matter dissolved in the sap, and is

* Described briefly by Francis Darwin in *Jour. Linn. Soc.*, 15 : 407. 1877.

found also in lines running up and sometimes down the rachis from the glands. These are very active during the rapid growth of the frond, their activity ceasing on the attainment of maturity. The secretion, which is very abundant, is formed independently of bleeding pressure, and the fluid is thick and syrupy. So rapidly does it accumulate that one may notice the increase in the size of the drops with a hand lens. The secretion escapes through modified stomata similar in form to the water-stomata of *Tropeolum*. The glandular tissue beneath extends deeply into the cortical mass of the petiole; its cells are small and contain chlorophyll.

Small ants, and one honey-gathering dipterous insect were noticed visiting the glands; none were seen to be gnawed by the insects. As F. Darwin observed, the plant has few natural enemies or none, and the teleological interpretation must be sought in the internal economy of the plant, probably in connection with nutrition. The abundant excretion of sugar may be a carrier of or an accompaniment to the excretion of some harmful substance. It is noteworthy that up to the present time no other Pteridophyte has been reported to be possessed of nectar-secreting organs. The plants on which the observations were made grew near Bantam Lake, Litchfield, Conn.

Dr. Britton remarked on a young tree of the Swamp Spruce, *Picea brevifolia* Peck, found during the day in a sphagnum bog near Litchfield, and stated that this was probably the most southern known station for this species in New England. The short glaucous leaves and nearly glabrous twigs readily distinguish this tree from the Black Spruce, *P. Mariana*.

Mrs. Britton exhibited specimens of the red-flowered Columbine of the Litchfield region, and remarked on its growth in open fields and the pubescent character of the plant, differing in these features from the plant of the vicinity of New York, which inhabits rocky ledges and is nearly or quite glabrous. She noted that the pubescent plant is also abundant in fields on the Pocono plateau of Pennsylvania.

A vote of thanks was tendered to Dr. Allen for his most generous and agreeable hospitality.

N. L. BRITTON,
Sec'y pro tem.

CURRENT NOTES ON METEOROLOGY.

CLIMATE AND THE ICE INDUSTRY.

THE practical use made of nocturnal radiation for the preparation of ice in certain parts of India has long been well known. The method pursued there is to expose shallow porous earthenware dishes filled with water and resting on rice straw, loosely laid in a small excavation on the surface of the ground. When the conditions are favorable, ice is formed in considerable quantities, even when the temperature of the air is 15° or 20° above freezing. A case of a somewhat similar kind is noted by O. H. Howarth, in a paper on 'The Cordillera of Mexico and its Inhabitants,' in the *Scottish Geographical Magazine* for June. In one of the highest valleys in Oaxaca, at an elevation of 8000–9000 feet, a flourishing ice industry was discovered. It is stated that the ground is covered with a large number of shallow wooden troughs, which are filled with water, and during the winter nights are covered with a film of ice of not more than one-eighth of an inch in thickness. This ice is removed in the morning, shovelled into holes in the ground, and covered with earth. Under these conditions the ice consolidates, and is then cut out in blocks and sent down by mules to the towns, where a ready market is found at all seasons.

FROST FIGHTING.

'Frost Fighting,' is the title of Bulletin No. 29 of the United States Weather Bureau, prepared by A. G. McAdie, local forecast official at San Francisco. The question of protection against frost has been very carefully studied by the Weather Bureau officials in California during the past four years, and every effort has been made to forecast coming frosts, and also to investigate the best methods of protection. Mr. McAdie says that "the experience of the past three years warrants the statement that the loss due to frosts in California, hitherto considered unavoidable, can be prevented, and that unless extreme conditions, by which is meant lower temperatures by 5° than have ever yet been experienced in this State, occur, the citrus fruits of California can be successfully carried through the period when frost is likely." The formation of frost is found to be very

largely a matter of air drainage, and every owner is urged to make a detailed study of the movement of local air currents in his own district. Various methods of protection are briefly described, including those based on mixing the air; warming the air; cloud or fog formation; irrigation; spraying, and screening. A 'warm water method,' adopted by Mr. E. A. Meacham, of Riverside, Cal., by which water, after being heated in a small boiler, is allowed to run in furrows through the orchard, is stated to have been successfully tried. The *Bulletin* contains a weather map showing the pressure and temperature conditions which are followed by heavy or killing frosts within 12 hours in southern California, and also gives plates illustrating the different methods of protection.

R. DeC. Ward.

Harvard University.

SCIENTIFIC NOTES AND NOTES.

Harvard University has conferred its LL.D. of Dr. W. H. Welch, professor of pathology in the Johns Hopkins University.

The University of Cracow has conferred an honorary degree on Professor Simon Newcomb, U. S. A., on the occasion of the celebration of its five hundredth anniversary.

The Paris Academy of Sciences has elected Professor L. Boltzmann a corresponding member in the place of the late Professor Beltrami.

We regret that we are unable to secure or to find in any of our exchanges any account of the third biennial conference on an International Catalogue of Scientific Literature beyond the fact that the delegates had a dinner.

By the action of the Massachusetts Senate on June 28th there will be no appropriation this year for the destruction of the gypsy moth.

It is proposed to celebrate the 70th birthday of Professor Wilhelm Wundt, which will occur on the 16th of August, 1902, by the publication a *Festschrift*, to which his former students are invited to contribute. The manuscripts must be forwarded to Professor Külpe, Würzburg, not later than January 1, 1902.

The directorship of the Paris Natural History Museum, vacant by the death of Professor Milne-Edwards, has been filled by the appointment of Professor Edmund Perrier.

Dr. Alfred Goldsborough Mayer, assistant of Mr. Alexander Agassiz, and in charge of Radiates at the Museum of Comparative Zoology, Cambridge, has been appointed curator of the Department of Natural Science in the Museum of the Brooklyn Institute of Arts and Sciences. He will assume his new position in September.

Sir George F. Hampson, Bart., who accepted an invitation to become an assistant in the Insect-room of the British Museum five years ago, has just been promoted to the post of first-class assistant, under a treasury regulation to which we have recently referred. He is the only assistant in the Natural History section of the museum to whom the benefits of this regulation have as yet been extended. But since there are many of his colleagues, men of equal reputation, who have served in the second class for twice, if not thrice, as long, it is anticipated that this good example will soon be followed. It is pleasing to find that after all, the Trustees of the British Museum are able to recognize exceptional merit, when they have special facilities for becoming personally acquainted with it.

The Geological Society of London has elected Professor Paul Groth, of the University of Munich, a foreign member, and Professor A. Issel, of Genoa, a corresponding member.

The Society of Arts has awarded its Albert medal for the present year to Mr. Henry Wilde, F.R.S.

The third of the biennial Huxley Lectures, founded in commemoration of the late Professor Huxley in connection with the Charing Cross Medical School, will be delivered by Lord Lister, President of the Royal Society, on Tuesday, October 2d.

Lord Avebury has been elected president of the Royal Statistical Society. The Society announces as the subject for its Howard medal 'The history and statistics of tropical diseases with special reference to the bubonic plague.'

We regret to record the death of Dr. Willy Kühne, professor of physiology and director of

the Physiological Institute of the University of Heidelberg, at the age of 62 years; of Dr. Reinhold Hoppe, docent in mathematics in the University of Berlin, aged 84 years, and of M. Bontain the French physicist.

IT is proposed to erect a monument in Simonstown in memory of the late Miss Mary Kingsley, the African explorer and botanist, who died of fever while engaged in nursing the Boer prisoners.

THE United States Civil Service Commission announces that on July 24, 1900, an examination will be held for the position of assistant ethnologist in the Smithsonian Institution at a salary of $50 a month. The examination will be chiefly on Indian languages and especially on Siouxan languages.

ON August 14th, there will be an examination for the position of assistant, Division of Entomology, Department of Agriculture, at a salary of $840 per annum. The examination will be on entomotaxy and especially on the orthoptera.

A MEETING of the Anatomical Society of Great Britain and Ireland was held at Owens College Manchester on June 21st and 22d.

IT is stated that there has been a meeting of cardinals and other ecclesiastical dignitaries at the Vatican to discuss the expediency of taking an active part in the movement for the prevention of tuberculosis.

AT the Blue Hill Observatory on June 19th a kite used in the exploration of the air was sent to the height of 14,000 feet, which exceeds the greatest height previously obtained there by 1440 feet. The temperature at this height was 15 degrees below the freezing point, the wind velocity was about 25 miles an hour from the northeast, and the air was extremely dry, although clouds floated above and below that level. The kites remained near the highest point from 5 to 8 p. m. They were then reeled in rapidly by a small engine. On the way down they passed through a stratum of thin ragged clouds at the height of 1½ miles. These were moving with a velocity of about 30 miles an hour. At this time the wind at the observatory, about 600 feet above the general level of the surrounding country, had fallen to a calm. The highest point was reached with 4½ miles of music wire as a flying line, supported by 5 kites attached to the line at intervals of about three-fourths of a mile. The kites were Hargrave or box kites of the improved form devised at the Observatory. They have curved flying surfaces modeled after the wings of a bird. The three kites nearest the top of the line had an area of between 60 and 70 square feet each, and the 2 others about 25 feet each. The total weight lifted into the air, including wire, instruments and kites, was about 130 pounds. This flight was one of a series being carried on by Messrs. Clayton, Ferguson and Sweetland. On June 18th the kites reached a height of 11,500 feet. They were sent up a second time the same evening and remained throughout the night at a height of nearly 10,000 feet. At this height the temperature remained from 5 to 10 degrees below freezing.

THE *Philadelphia Medical Journal* reports that the plague is increasing in Australasia. Many cases are reported in Victoria, which probably started in the slums of Melbourne. In the city of Sydney, 239 cases have been reported, with 82 deaths. The extension of the plague to Sydney has caused much disturbance to business. The number of cases is rapidly increasing, in spite of the efforts at destruction of rats and disinfection. The government distributes free to all householders a special rat-poison and sends men to remove dead rats. About 8000 persons have been inoculated with Haffkine's prophylactic. A few days later two or three of those inoculated were attacked by the disease. Dr. Tidswell, the bacteriologist of the New South Wales Health Department, is said to have found plague-bacilli in the alimentary canal of fleas taken from plague-infected rats. The *British Medical Journal* reports 100 deaths daily in Calcutta, and the total mortality is double that number. The local government interferes as little as possible with the domestic affairs of the people. No pressure is used to send cases to the hospitals and many remain untenanted. This system has one advantage—that it does not cause a panic and consequent flight of a large portion of the inhabitants, which would result in spreading the disease over the province. On the other hand, no de-

crease of the disease in the city can be expected to follow such measures, and it is not surprising that the usual annual increase is greater this year.

UNIVERSITY AND EDUCATIONAL NEWS.

THE total amount of the bi-centennial fund of Yale University is now $1,090,000. This sum includes $490,000 subscribed or pledged unconditionally to the general building fund; $250,000 pledged conditionally in case three additional subscribers can be found to give $100,000 each, thus making possible the carrying out of the building plan and $350,000 given or pledged for special purposes other than those of the general building fund. During the year the university has received also the Vanderbilt bequest of $100,000 free of tax; $50,000 from the estate of Charles J. Stillé; $30,000 from the estate of Professor O. C. Marsh, and $15,000 from the estate of Catherine W. Jarman, making, with minor legacies, about $200,000. The University has further just received from Mr. W. E. Dodge of New York City the sum of $30,000 "for the purpose of promoting among its students and graduates and among the educated men of the United States an understanding of the duties of Christian citizenship and a sense of personal responsibility for the performance of those duties." The income of the fund will be paid each year for a series of lectures.

THE sum of $109,000 covering the debt of Wellesley College has been raised making available a gift of $100,000 from Mr. John D. Rockefeller.

THE daily papers contain a dispatch from Havana regarding an alleged scandal in the University, where some of the best known men in Cuba are said to have received $24,000 a year each as professors. There were 72 of these professors and 24 assistants, some of them having no classes at all and others only one or two students. Many of the professors drew other government salaries. When this was called to General Wood's attention he immediately inaugurated reforms, which resulted in cutting down the list to 46 professors and assistants. So at least runs a cablegram from Havana on which perhaps not very much reliance should be placed.

THE United States transport *McPherson*, having on board 231 of the Cuban teachers who will attend the summer school at Harvard University, arrived in Boston harbor on June 30th.

PROFESSOR CHARLES L. EDWARDS, recently of the University of Cincinnati, was elected on June 26th to the professorship of natural history, in Trinity College, Hartford. The new Hall of Natural History, just completed at a cost of $60,000, is a building of three stories above a high basement, and is designed for the various needs of biology and geology. There are suites of laboratories for anatomy, physiology, experimental morphology, zoology, botany and geology, together with a vivarium. The southern half of the building, provided with a large central light well extending from the first floor to the arched roof, is the museum. The already valuable collections of Trinity College, including the Ward series of invertebrates, vertebrate skeletons and Blascke models will be largely augmented in the near future. Professor Edwards will supervise the equipment of the laboratories during the summer.

THE following appointments are also announced: H. T. Cory, a graduate of Purdue University, now in charge of the engineering courses in the University of Missouri, professor of civil engineering in the University of Cincinnati; Dr. Franz Pfaff, assistant professor of pharmacology and therapeutics of the Harvard Medical School; Dr. L. E. Dickson has resigned his position as associate professor of mathematics in the University of Texas, to accept a call to the University of Chicago; Dr. Grace N. Dolson, a graduate of Cornell University, has been made professor of philosophy at Wellesley College; at Princeton University, Professor E. O. Lovett has been promoted to a full professorship of mathematics, and Mr. A. A. H. Lyba has been called to a professorship of mathematics at Roberts College, Constantinople; Dr. George V. N. Dearborn has been appointed assistant professor of physiology in the Tufts College Medical School. He succeeds Dr. Albert P. Mathews, who has been called to an instructorship in physiology in the Harvard Medical School.